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ABSTRACT

To meet the current demand for certified aviation mechanics and satisfy student learning needs, a nationwide study developed a core curriculum based on related technical knowledge and skills. Endorsed by the Federal Aviation Administration (FAA) this 5-year study modified a number of the emerging concepts appropriate to vocational education and integrated them with proven techniques used in vocational curriculum development. The first phase of the study involved the construction of a questionnaire and the development of a system for gathering, storing, and analyzing necessary data. The second phase, or testing phase, made use of a bi-variate inversion method to determine the effectiveness of the curriculum using as criteria student performance goals, levels of instruction, and continuous feedback from students. Phase Three then resulted in the development of the common core curriculum through the efforts of 100 aviation mechanic instructors. Also resulting from this study was the revision of the Federal Air Regulations, Part 147, thus providing more specific guidelines for the certification and operation of these schools. It was recommended that the FAA establish a system to periodically survey this industry for the purpose of updating this curriculum. (JS)

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FINAL REPORT
Project No. 5-0189
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A National Study of the
AVIATION MECHANICS OCCUPATION

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VT 012 081

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Phase I

Phase II

Phase III

A NATIONAL STUDY OF THE AVIATION MECHANICS OCCUPATION

Introduction

The alignment of curriculum and instructional processes with student learning requirements and job demands (both for initial employment and vertical and horizontal movement after employment) has been one of the major tenets of vocational education. Through the years, a number of workable techniques have been used to attain this desired alignment. The degree of alignment has varied among different curriculums within a particular school as well as among different schools throughout the nation. Schools having active advisory committees and progressive vocational administrators and instructors appear to have achieved greater alignment than schools having tradition oriented individuals assisting in curriculum development.

Several new concepts in curriculum development have emerged in recent years; some have already been utilized in vocational education. The processes implemented in this study modified a number of the emerging concepts that were appropriate to vocational education and integrated them with proven techniques used in vocational curriculum development. By using a computer, research data was readily transposed into instructional content that was applicable to a number of industrial categories within an occupational family and that indicated the depth of instruction required for each topic.

In 1965, a study was undertaken in California for the purpose of developing a common core curriculum for aviation mechanic programs in the schools of California. This common core curriculum was designed to meet both current job demands and student learning needs by providing the necessary scope and depth of technical and manipulative skill instruction for becoming a certificated aviation mechanic. Prior to implementing the study, a questionnaire was designed with the assistance of an advisory committee and refined through a series of "dry run" contacts with industry.

Toward the conclusion of this initial study, the Federal Aviation Administration reviewed preliminary findings and suggested that the study be extended on a nationwide basis. Discussions were held with the Federal Aviation Administration (FAA), the Air Transport Association of America (ATA), and the Aviation Technician Education Council (ATEC). With their endorsement, a proposal was submitted to the United States Commissioner of Education who subsequently accepted the project for funding under the provisions of Section 4 (c) of the Vocational Education Act of 1963. The results of this national study are reported in this document.

The national study consisted of three phases, with the third phase containing two parts. Since each phase was thoroughly reported and documented in the publications contained in Appendix C, the ensuing pages will provide only an overview of the total study.

Objectives

During the study, revised proposals for its continuation had to be submitted to the U.S. Office of Education which required the restatement and sequencing of objectives. The basic objectives of the study were not changed; however, they were simply reformulated to conform to the several phases of the study. The final objectives for the three phases were as follows:

Phase I

1. To investigate the technical knowledge and manipulative skills required of aviation mechanics by the aviation industry.
2. To identify a common core curriculum for the training of aviation mechanics.

Phase II

1. To determine instructional methods and techniques that can help aviation mechanics learn more effectively and efficiently.
2. To compare differences in teaching effectiveness between instructors trained in the use of prepared materials based on the new common core curriculum and instructors untrained in the use of these specially prepared instructional materials.

Phase III, Part 1

1. To provide teacher training embodying modern instructional techniques for one hundred practicing teachers from aviation mechanic schools, using the methods validated in Phase II.
2. To develop an updated common core curriculum covering all topics in the training of aviation mechanics in accordance with the findings of Phase I and the subsequent experimental project in curriculum development of Phase II, and to incorporate such material into a specialized guide for instruction.

Phase III, Part 2

1. To resurvey 30 percent of the companies studied in Phase I for the purpose of identifying changes in technical and manipulative skill requirements for the aviation mechanic.

2. To develop and test a procedure for maintaining the common core curriculum current with changes in the aviation industry.

Study Design

Each phase of the study had its own design; each design was developed with the intent of obtaining optimum results in relation to the objectives for each particular phase.

The design for Phase I consisted of a system for collecting the data (a task inventory), a system for compiling the data in a form that identified the common tasks within differing industrial categories in the aviation mechanics occupation, and a system for analyzing the data by a national advisory committee which in turn recommended the curriculum content and levels of instruction necessary for training certificated aviation mechanics.

In Phase II a bi-variate inversion method was used to test the effectiveness of an experimental subject curriculum. Randomization and replication were utilized as fully as possible. Through the findings of Phase II, the activities of Part 1 of Phase III were determined.

The design for Part 1 of Phase III consisted of ten workshops for one hundred aviation mechanic instructors for the purpose of developing a common core curriculum as identified in Phase I and including the instructional format found to be effective in Phase II. Each of the first five workshops was devoted to one of the five major parts of the curriculum. The second group of five workshops replicated the subject matter of the first five and refined the curriculum materials developed during the first series of workshops.

Chronological Review

The National Study of the Aviation Mechanics Occupation required five years to complete, from initial operating date to the submission to the U.S. Office of Education of the final report. A chronological review of the study activities is hereby presented.

The study was funded and staffed for operation beginning October 1, 1965. As the initial task, a fifteen-member National Advisory Committee representing a broad spectrum of the aviation industry was assembled. The composition of the Committee was as follows: representing airlines, two members; representing large general aviation companies, two members; representing small general aviation companies, two members; representing private schools, two members; representing public schools, two members; representing the Department of Labor, one member; and representing the Federal Aviation Administration, four members. (See

Appendix A for the names of the members.) All but two Committee members (who were replaced) remained throughout the entire study. The Advisory Committee's interest and support greatly contributed to the success of the study. This was also true of the U.S. Office of Education, which provided continuity of direction through Dr. Sidney High for the first year and Mr. Larry Braaten for the remaining four years, and of the Federal Aviation Administration, from which support and guidance throughout the entire study were given primarily by Arthur Elwell, Harry Pickering, and Keith Teasley.

On November 17, 1965, the first National Advisory Committee meeting was held at the FAA Aeronautical Center, Will Rogers Field, Oklahoma City, Oklahoma. During this meeting, refinements were made in the questionnaire used in the California study and an additional questionnaire to determine level and recency of training was developed at the request of the Department of Labor representative. The findings from both questionnaires were reported in the Phase I report.

To begin the national survey, the United States was divided into six geographic areas. The selection of these areas was determined by studying the locations in which the heaviest concentration of airline stations and general aviation companies could be found. Concurrent with the area selections, a manual was prepared to be used by six Survey Data Acquisition Technicians[1] during the collection of the data. The manual contained methods by which the technicians were to conduct the survey, a system for keeping the research staff at UCLA informed of their progress, and a preplanned routing and visitation schedule.

Six technicians were recruited and each had an individual orientation session with a member of the research staff. (See Appendix B.) These sessions were designed to acquaint the technicians with the survey procedures and to insure uniform use of these procedures by all six technicians.

During the first three months of 1966, the survey data were collected and processed through the computer. Preliminary computer print-outs were compiled for analysis by the National Advisory Committee. The second National Advisory Committee meeting was held at Purdue University, Lafayette, Indiana, on April 12-13, 1966. Copies of the complete computer print-out were distributed to each Committee member for analysis in preparation for the establishment of a common core curriculum. Prior to analysis of the data, the Committee agreed upon a set of rules for reaching consensus when making their recommendations. The Committee divided itself into four groups by subject area: powerplant, airframe, electrical, and general. Each group evaluated the pertinent tabulated data and developed recommendations. These recommendations were then presented to the entire Committee, topic by topic, and a curriculum was then formulated. The results of this part of the study were reported in A National Study of the Aviation Mechanics Occupation. (See Appendix C.)

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[1] Referred to as Survey Analysts in the 1966 and 1970 survey reports found in Appendix C.

Perhaps the most outstanding facts substantiated by Phase I of the study were:

(1) There does indeed exist a common body of tasks performed by all aviation mechanics that requires similar levels of technical knowledge. This finding helped identify a common core of activities that should be a part of the aviation mechanic's curriculum.

(2) Seventy-three percent of the tasks require the aviation mechanic to have technical knowledge and abilities that permit him to abstract principles from concrete situations and apply them to new problems. This transfer of knowledge to new situations requires a high degree of learning and is necessitated by the sophisticated equipment typical of the aviation industry.

(3) The aviation industry provides extensive in-service training, a fact that was substantiated by the questionnaire requested by the Department of Labor Advisory Committee Representative.

With the completion of the report mentioned above, the objectives of Phase I were met. Two thousand copies of the report were printed; however, the number of requests was so large that an additional 2,000 copies were made available for dissemination. The publication has now been distributed throughout the world and is used in many countries to determine subject content for training aviation mechanics.

Phase II of the study began in September, 1968, and consisted of an experimental program to test new training methods and curriculum for aviation mechanics based on the findings of Phase I.

To investigate ways of creating an innovative curriculum, a short experimental curriculum was developed. The curriculum contained three major concepts: (1) student performance goals (behavioral objectives), (2) levels of instruction, and (3) continuous feedback from students to teacher.

The student performance goals provided a way for instructors to determine when predetermined observable changes occurred in each student's performance. Two types of objectives were used in the experimental curriculum, one for overall instructional units and another for the various instructional segments making up the total unit. These segment objectives helped ensure that each segment of learning occurred within the total unit, thereby permitting achievement of the overall instructional objectives.

Levels of instruction which were determined by the National Advisory Committee from the survey results, were designed so that the appropriate depth of training could be reached without over- or under-training. They also aid in determining the most prudent use of time in the instructional program.

The system for continuous feedback from the student to the instructor required a pre-planned comprehensive listing of questions, problems, and activities that were consistent with the instruction and that were utilized at the time the instruction was given. Feedback was used to solicit either a student's restatement of ideas or the performance of a task that he had just learned. Further instruction did not commence until the instructor was satisfied with the results of the feedback.

A bi-variate inversion was used to test the effectiveness of the experimental curriculum. Twelve instructors were selected to participate in the experiment, six from private schools and six from public schools. Two groups of six were formed. Each instructor presented two methods of instruction to his students. One method was of his own choosing although the instructor was given the overall behavioral objectives for the instructional area he selected. The other method was the one in which the instructor received teacher training in the use of the experimental curriculum. One group of instructors used their own teaching methods first, for a period of two weeks; then they received training in the use of the experimental curriculum for one week and taught this experimental curriculum for two weeks. The second group of instructors used a reversed procedure in training and presentation of instruction. In all cases, the instructors taught the same class of students throughout the experiment so that a test could be made of the hypothesis that teachers given specially designed instructional materials and assistance in the use of these materials would have their students attain a greater degree of learning achievement than teachers not having specially prepared materials and training. The null hypothesis stated that there would be no difference in learning achievement between the two instructional methods.

When the teachers received their training in the use of the experimental curriculum, they were given a teacher's handbook and a prepared student workbook. The teacher's handbook contained behavioral objectives, key points for presentation, and feedback activities which were directly related to levels of instruction. The teacher's handbook and student workbook were designed as companion books to be used concurrently by the teacher and the student. All vital teaching points in the instructor's book were keyed to matching points of importance in the student's book. This was done so that the instructor could work closely with each student to make certain all essential information was covered. The student workbook also included step-by-step diagrams of hydraulic components; it provided space for student drawing and notetaking; and it listed comprehensive quizzes at the end of each section.

With the assistance of the Federal Aviation Administration, final examinations were developed with validated test questions. These test questions were selected after a review of the statistical information recorded by the FAA which indicated how well each question related to the student performance goals of the various instructional segments within the experimental and control curriculums. The examinations with validated questions were administered to experimental and control subjects on the last day of the 60 hours of instruction for each group. There were 144 students involved in the experiment.

Initial test results indicated a significant difference between the students' mastery of the experimental subject (hydraulics) and their mastery of the control subjects. The same examination, with only the sequencing of question items changed, was readministered to the 144 students after a 90-day period. Again, it was found that there was significantly greater learning and retention of the experimental subject than the control subject. A six-month follow-up was made of these students to determine their success on the FAA mechanic certification tests. Data was obtained for 98 of the 144 students who had participated in the experiment. It was found that, although hydraulics was the second most difficult subject on the examination, these 98 students scored 7.4 percent higher than the national average and achieved higher scores in hydraulics than in any of the other areas in which they were tested.

Although caution must be exercised in making definitive conclusions in light of the limited scope of this study, evaluation of the data indicates the following:

1. When student performance goals are clearly defined and are known by both the teacher and the student, the quality and the quantity of learning will improve.
2. When the levels of instruction are known and adhered to, more efficient instructional planning and, therefore, more efficient classroom instruction will take place.
3. When feedback checks for learning are prepared in detail prior to each lesson and the teacher utilizes these checks during instruction, student learning achievement increases.
4. When improved instructional planning and teaching methods are used, instructional time may decrease without a loss in learning.

5. When teachers are trained to use prepared instructional materials and to utilize student performance goals and continuous feedback, students achieve greater depth of learning and retention.

Some indications suggest that the number of instructional hours devoted to the subject is not the only important criterion for increased learning. In this study, it was noted that regardless of the number of hours devoted to teaching the control subjects, students failed to achieve the same level of excellence on the examination questions concerned with these subjects as they did on questions concerned with the experimental subject. In fact, performance in some areas declined with increased instruction, suggesting the possibility of retroactive inhibition. Study results suggest that the use of levels of instruction, student performance goals, and feedback in instructional presentation, curriculum organization, and instructional planning can influence the amount of time necessary to teach a particular subject. It should be emphasized, however, that regardless of the amount of previous teaching experience, the success of instruction will be limited without proper teacher preparation and acceptance of the experimental concepts.

The results of Phase II were reported in Phase II, A National Study of the Aviation Mechanics Occupation. (See Appendix C.) Two hundred and fifty copies of this report were printed and disseminated. The completion of this report met the objectives of Phase II of this study.

In 1967, during the completion stages of Phase II, a proposal,was submitted to the U.S. Office of Education requesting funds to complete the remainder of the study (Phase III). However, because of budgetary activity in Congress, the continuance of the project was delayed until January, 1968.

The basic plan for Part 1 of Phase III consisted of two consecutive series of five two-week workshops for instructors from aviation mechanic schools. These workshops consisted of three major activities: (1) developing curriculum materials for all instructional topics recommended for the training of aviation mechanics, (2) introducing the instructors to the latest technological advancements through presentations by specialists from the aviation industry, and (3) upgrading participating instructors' skills in current educational technology.

Concurrent with the start of the workshops, the FAA published an Airframe and Powerplant Mechanics Certification Guide AC 65-2A, which incorporated the results of Phase I of the National Study of the Aviation Mechanics Occupation. The curriculum materials developed at the workshops utilized the information contained in the guide.

The workshops were scheduled at one-month intervals, with ten instructors attending each, along with members of the research staff and industry specialists who served as resource persons. Each of the first five workshops addressed itself to one of the following curriculum areas: Airframe Structures, Airframe Systems and Components, Powerplant Theory and Maintenance, Powerplant Systems and Components, and General Curriculum Subjects. Upon completion of these workshops, a second series of five workshops followed replicating the first five and refining the materials already developed. Activities of all ten workshops followed suggestions of the National Advisory Committee as well as recommendations from the FAA.

The initial workshop, on Airframe Structures, began on April 29, 1968, and the final workshop, on General Curriculum, began in March of 1969. It was during these workshops that the curriculum materials contained in the Phase III, Part 1 report were developed. Student performance goals and feedback items were formulated with reference to the recommended depth of instruction for each major topic. Each workshop was first divided into three teams which concentrated on particular aspects of the curriculum area; later all participants met together to refine each team's suggestions. In this way, the instructors developed a complete curriculum with emphasis on instructional levels, student performance goals, and feedback.

The National Advisory Committee met twice during this period. The first meeting, in Boston on April 16, 1968, was concerned with identification of major areas that should be emphasized during the workshops. The second meeting, in Washington, D.C., on April 22, 1969, was concerned with a review of the workshop accomplishments and the establishment of procedures for conducting Part 2 of Phase III of the study. The recommendations given by the Advisory Committee were incorporated in both the procedures for finalizing the format for curriculum materials and the procedures for conducting the resurvey activities of Part 2 of Phase III.

During the last year of the study, the FAA enacted a rule change to FAR 147 which was based on the national study. In addition, the curriculum materials developed by the participating one hundred instructors were edited and written in the format recommended by the National Advisory Committee, and Part 2 of Phase III was completed.

The resurvey conducted in Part 2 of Phase III used the same geographic areas and data collection system used in Phase I. Thirty percent of the companies that participated in the Phase I study were resurveyed. Procedures for recruiting and orienting the survey technicians were identical to those used during Phase I. In November and December of 1969, data from the parti- current requirements of the aviation industry and the necessity for continuous adjustment of school curriculums.

was prepared for each member of the National Advisory Committee. The final meeting of the Committee was on April 14, 1970, at Tulsa, Oklahoma. During this meeting, the results of the resurvey were analyzed and recommendations were again made as to curriculum content and teaching levels necessary to meet the current requirements of the aviation industry.

In addition to the identification of industrial requirements, Part 2 of Phase III attempted to develop and test a procedure for maintaining the common core curriculum current with changes in the aviation industry. The system developed and tested resulted from the use of two different types of questionnaires. It was found that once a thorough study has been made, as was done in Phase I, knowledgeable individuals working in an organized advisory capacity can make recommendations for adjustments which will keep the curriculum current with changes in industrial requirements.

On reviewing the National Advisory Committee's recommendations for adjustment of task levels, it was apparent that some of the major topics and tasks included thereunder received level designations significantly different from those originally established in 1966. These Committee recommendations, based on the 1970 findings, lowered 35 percent of the task levels and raised 20 percent of the task levels. These recommendations for adjustment reflect the current requirements of the aviation industry and the necessity for continuous adjustment of school curriculums.

Two questionnaires were used during the resurvey. One was an exact duplicate of the questionnaire used in 1965-66; the other also duplicated the original but included the data obtained in 1965-66. A review of these two questionnaires indicated that there was little difference between the responses given on the original questionnaire and the modified questionnaire. The frequency, technical knowledge, and manipulative skill data were very similar, regardless of the sampling questionnaire used.

The research findings should provide the FAA with an inexpensive method for keeping curriculum requirements for aviation maintenance technician schools current with industry requirements. Following periodic comparisons of existing data with recent, small samplings from the aviation industry, adjustments to curriculum can be made.

With the completion of the publication of the Phase III report, the objectives for Phase III were met. The distribution of this report to the aviation schools of the nation should be of great assistance in the writing of their new curriculums as required by the revisions in FAR 147 and should assist in providing more effective instruction.

Finally, with the revision of FAR 147, which became effective May 3, 1970, members of the research team conducted a series of six workshops for FAA inspectors. The purpose of these workshops was to acquaint the inspectors with the concepts integrated into the curriculum materials which were developed during Part 1, Phase III and to provide them with improved skills in evaluating school curriculums. The involvement of instructors, FAA inspectors, and industry representatives in the activities of this study should set the foundation for a more uniform and effective effort in the training of aviation mechanics in our nation.

Study Results

Each of the study objectives was met and a number of significant results occurred which either affect the training of aviation mechanics or the utilization of study techniques in vocational education curriculum development.

One of the major results of the study was the revision of sections of the Federal Air Regulations, Part 147, based on the results found in Phase I of this study. Revisions included a change of name from "mechanic school" to "aviation maintenance technician school," more specific guidelines for the certification and operation of these schools, and new minimum curriculum requirements which reflect technological advances of the aviation industry in line with the capability of school instruction. The degree of difficulty of the aviation mechanic's certification examination questions has also been revised to match the teaching levels specified in FAR 147. This concept of teaching levels was originally established in the national study. The practice of informing examinees of their areas of weakness even though they pass the examination was originally established by the national study and is now a common practice of the FAA.

The complete development of the curriculum, including student performance goals, technical and skill instruction information, and feedback and manipulative performance check items should be of great assistance to aviation maintenance technician schools. With the FAR 147 requirement that all aviation maintenance technician school curriculum be revised within two years, the curriculum materials contained in Part 1, Phase III, of the study should be most helpful. Involvement of the one hundred instructors from throughout the nation who developed the instructional content should be of great assistance in its implementation.

During the month of May, 1970, five workshops were conducted for FAA inspectors who would have responsibility for evaluating the new curriculums submitted by the schools to meet FAR 147 requirements. The concepts taught in these workshops were identical to those identified in the study and developed in the curriculum materials. Three additional workshops for

FAA inspectors have been completed since May. It is possible that this type of activity may continue for a number of years and help to unify the aviation maintenance technician schools' curriculum with the regulatory activities of the FAA, the job demands of industry, and the instructional needs of students.

A number of other studies utilizing the techniques of this study have been completed or are currently being conducted. Among these studies is the Firemen's Occupation Study that reviewed nine ranks in four different fire department categories. Results of this study are now being integrated into firemen curriculums. A study of the Air Traffic Controller Occupation utilized the same techniques used in this study, but included an innovation whereby the final tabulated data were printed out by the computer as student performance goal statements. This ability to directly transform survey data into performance statements can be classified as a major breakthrough in curriculum development. Two additional studies, one in automotive emission control and inspection and the other in a number of allied health occupations, are utilizing the techniques and processes that originated in the National Study of the Aviation Mechanics Occupation.

Recommendations

As a result of the study activities, a number of recommendations for the further improvement of the training of aviation mechanics are herein presented. It is hoped that these recommendations can be implemented so that the gains presently achieved can be capitalized upon. These recommendations are:

1. The FAA should establish a system for periodically resurveying the aviation industry for the purpose of updating aviation maintenance technician school curriculums.
2. The active cooperation between industry, schools and the FAA that was demonstrated during this study should be encouraged and continued.
3. The FAA should establish a communication link with recognized educational and industrial leaders to advise them on a regularly scheduled basis regarding policy matters related to airmen certification and training.
4. The FAA with industry assistance should establish and operate a centralized curriculum and technical data center for the continuous dissemination of technical information to the aviation maintenance technician schools for the purpose of keeping instructors technically current and curriculums relevant to the aviation industry.

5. The FAA, with the schools, should establish a student follow-up system to provide additional data for the evaluation of school instructional programs and for checking the validity of the FAA certification tests.
6. The FAA and the schools should both assume responsibility for providing workshops for instructors and inspectors for the purpose of upgrading both in instructional technology and curriculum development.
7. The FAA and industry should engage in cooperative ventures to provide mechanics already in industry with increased opportunities for professional updating and advancement.

Acknowledgements

The accomplishment of a major undertaking brings satisfaction to those participating in the achievement. From beginning to end the activities of this study achieved each prestated goal. This success was due to the contributions of many individuals. Their willingness to assist whenever requested not only aided in the final attainment of the study, but made the study an enjoyable undertaking. In fear of overlooking one in listing the many individuals that have contributed in some measure, sincere gratitude is expressed by the principal investigator to all the many from the aviation industry; the educational community; the FAA; the Division of Comprehensive and Vocational Education Research, USOE; and above all, the clerical and professional staff of the research team.

APPENDIX A

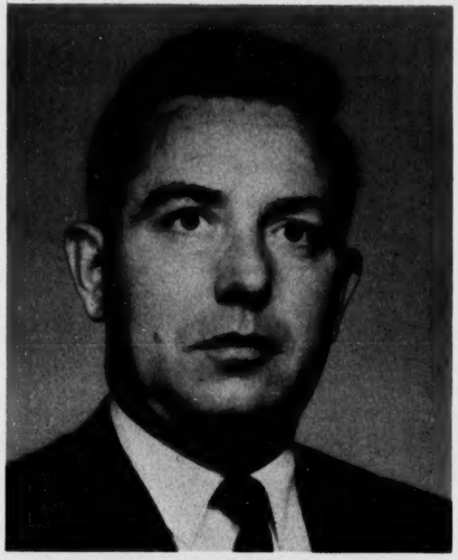
APPENDIX A
NATIONAL ADVISORY COMMITTEE 1965–1970

INDUSTRY REPRESENTATIVES

C. Bill Gregg, Director*
Technical Training and Qualifications
American Airlines
Tulsa, Oklahoma – 1965–1967

Robert Rich*
Director, Product Engineering
American Airlines
Tulsa, Okla. – 1967–1970

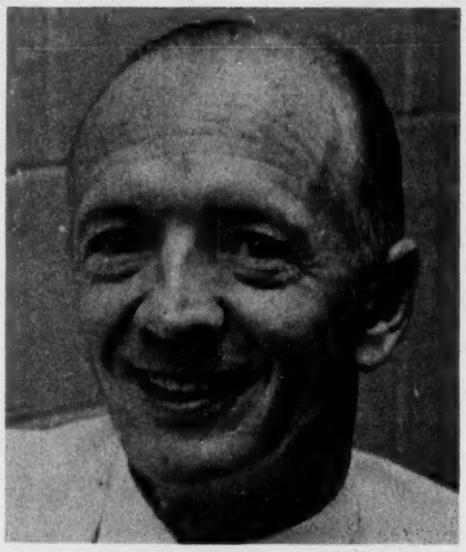
J. J. Tordoff
Manager of Personnel Management
United Air Lines
San Francisco, California – 1965–1970



Harry A. Palmer
Service Manager
Vroman Aviation Inc.
Midland, Texas – 1965–1970

Dan Westfall**
Director of Maintenance
Oklahoma State University
Stillwater, Okla. – 1968–1970

B. B. Ashlock***
Training Director
Airlock Corp.
Millville, N. J. – 1965–1967

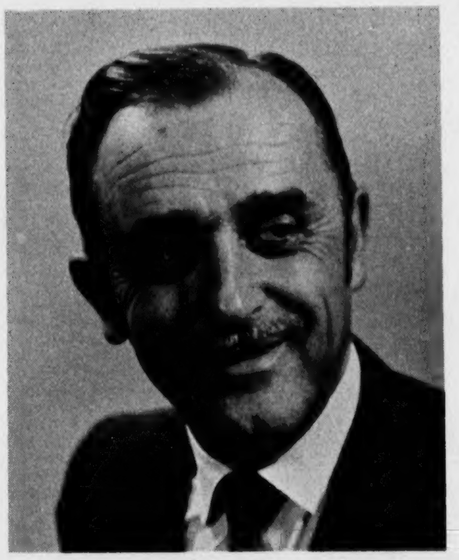


John Hite***
Manager, Aircraft Maintenance Service
Atlantic Aviation
Wilmington, Delaware – 1967–1970

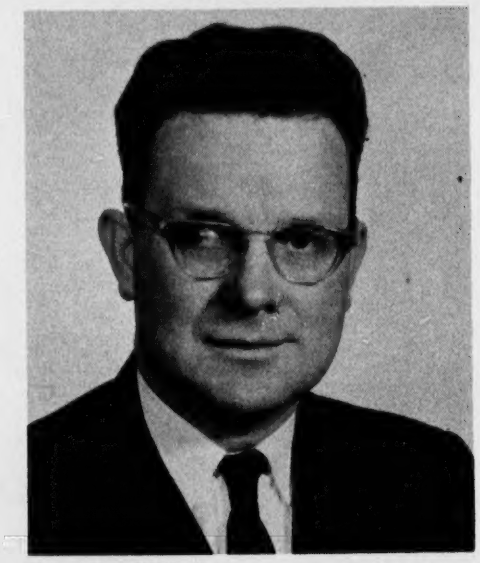
Rex H. Madeira
President
Page Aircraft Maintenance, Inc.
Dothan, Alabama – 1965–1970

NOTE: Dates indicate years served on the committee. *Mr. Gregg whose present title is Division Vice-President-Passenger Service, Eastern Airlines and was replaced on the committee by Mr. Rich. **Mr. Westfall replaced Mr. E. G. Willis, Manager Quality Control-Aero Corporation, Lake City, Florida (we were unable to obtain a photograph of Mr. Willis). ***Mr. Hite replaced Mr. Ashlock.

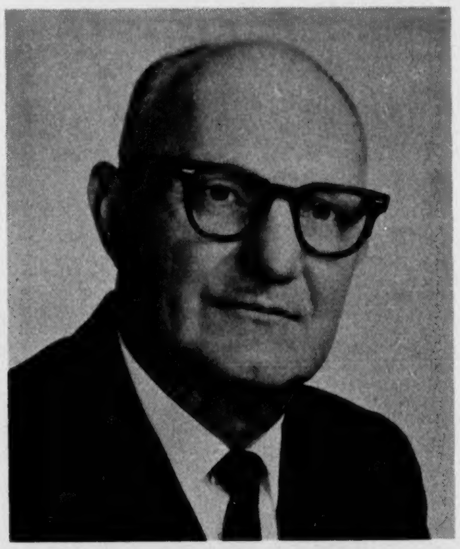
SCHOOL REPRESENTATIVES



Nicholas Birta
Principal
Aero-Mechanics H.S.
Detroit, Michigan – 1965–1970



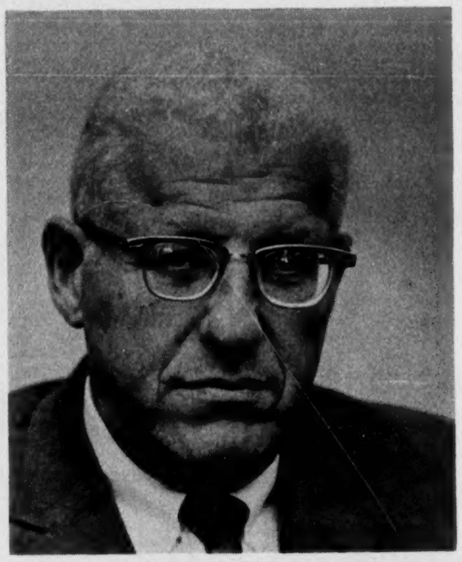
James M. Fisher
Vice President
Pittsburgh Institute of Aeronautics
Pittsburgh, Penn. – 1965–1970



Anthony Vai
Director of Aviation Maintenance Training
Northrop Institute of Technology
Inglewood, California – 1965–1970

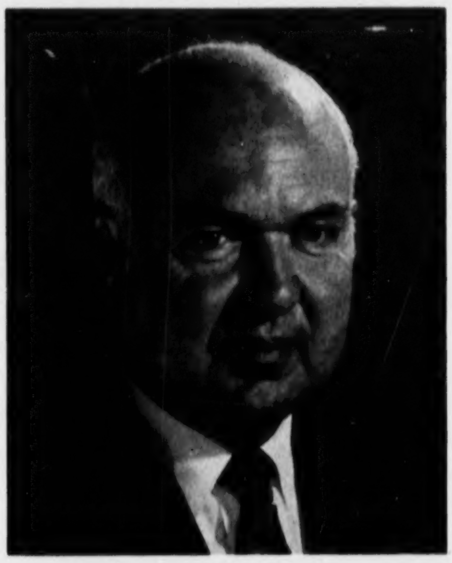
Frank Woehr
Principal, Aviation H.S.
Long Island City, N.Y.
1965–1970

UNITED STATES DEPT. OF LABOR REPRESENTATIVE



Howard Rosen
Director, Office of Research and
Development, Manpower Administration
U.S. Dept. of Labor – 1965–1970

FEDERAL AVIATION ADMINISTRATION REPRESENTATIVES

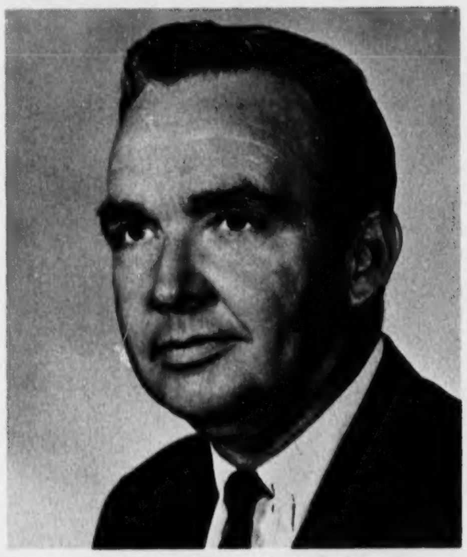


James E. Christopher
Southwest Regional Office
Fort Worth, Texas – 1965–1970

Arthur W. Elwell
Flight Standards Technical Division
Oklahoma City, Okla. – 1965–1970

Harry B. Pickering
Maintenance Division,
Flight Standards Service
Washington, D.C. – 1965–1967

Keith Teasley
Maintenance Division,
Flight Standards Service
Washington, D.C. – 1967–1970



Charles W. Schaffer, Jr.
Principal Maintenance Inspector
General Aviation District Office,
Pittsburgh, Penn. – 1965–1970

APPENDIX B

APPENDIX B
1965 SURVEY DATA ACQUISITION TECHNICIANS

See 1966 and 1970 survey reports in Appendix C for distribution of geographic area perimeters.

AREA
I

James W. Carlson

AREA
II

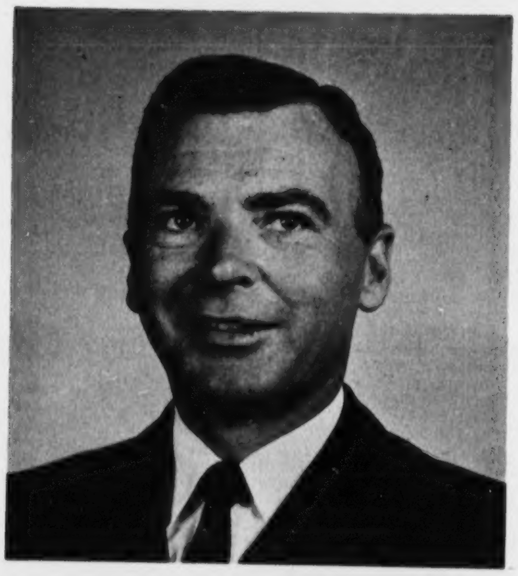
Stanley L. Moore

AREA
III

William J. Schill

AREA
IV

Ira W. Brown



AREA
V

John N. White

AREA
VI

Roger M. Turner

1970 SURVEY DATA ACQUISITION TECHNICIANS

AREA
I

E. L. Andrews

AREA
II

W. H. Brubaker

AREA
III

Ronald R. Ault

AREA
IV

Edward F. Chinchello

AREA
V

Roger M. Turner

AREA
VI

Everett C. Thomas

APPENDIX C

A National Study of the

AVIATION MECHANICS OCCUPATION

David Allen • John M. Meyer • Alvin Gorenbein • William K. Bowers

A Cooperative Study between the
Division of Vocational Education,
University of California, Los Angeles;
Bureau of Industrial Education,
California State Department of Education; and
U.S. Office of Education
1966

A National Study of the

AVIATION MECHANICS OCCUPATION

1966

David Allen
Supervisor Trade & Technical Teacher Education. Principal Investigator

John M. Meyer
Deputy Principal Investigator

Alvin Gorenbein
Senior Subject Area Supervisor—Powerplants

William K. Bowers
Subject Area Supervisor—Airframes

- VOCATIONAL AND TECHNICAL EDUCATION CONTRACT OE-6-85-043
- VOCATIONAL EDUCATION ACT OF 1963, SECTION 4 (C)
- THE PROJECT REPORTED HEREIN WAS SUPPORTED BY A GRANT FROM THE U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE.

Preface

The project concerning the aviation mechanics occupation was conducted by the Division of Vocational Education as a part of the work of its Center for Research and Service.

The curriculum innovations and data presented in this study offer important contributions to assist vocational educators in the field of aviation mechanics training. The ability to provide the aviation technical schools, on a national level, with current data from all regions and segments of the industry is of immediate and continuing importance. The techniques employed in this study to develop the aviation mechanics core curriculum can be applied in other occupational areas. The industry, the school, the teacher, and the student can in concert advance their educational objectives and needs through research of this type.

Funds to support the research were provided by the United States Office of Education under the provisions of Section 4(c) of the Vocational Education Act of 1963, and by the California State Department of Education, Bureau of Industrial Education. The staffs of the Division of Vocational Education, University of California, Los Angeles, and the Bureau of Industrial Education, California State Department of Education, planned, conducted, and coordinated the study.

Melvin L. Barlow, Director
Division of Vocational Education
University of California

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Introduction

A universal concern for the safety of aircraft passengers and flight crews has long been an integral element of the aviation industry. This concern has been revealed in the efforts made by the men and women employed in the industry to uphold and achieve the highest standards of craftsmanship. The creation of state and federal agencies to administer safety regulations has been a further exemplification of a sustained interest in maintaining safety of flight.

Foremost among those who form the work force of the aviation industry are the aviation mechanics, who are characterized by their dedication to air safety and pride of workmanship. Involvement in safety of flight is a part of the working life of each mechanic throughout his employment in aviation. This theme is stated repeatedly in the instruction he receives. Pride of workmanship is a characteristic that develops in the student mechanic from the time he first enters aviation mechanics school. As his skill and knowledge increase, confidence in his ability to perform well also increases, leading to a feeling of pride in his accomplishments and causing him to seek further improvement of his skill and knowledge.

There is in fact no point in his career at which an aviation mechanic can rest in the knowledge that he is fully prepared for the remaining years he may work in aviation. The changing technology of aviation is reflected by new equipment, new aircraft, and constantly recurring changes in aviation engineering. Each change demands that the mechanic have immediate command of the skill and knowledge needed to perform the necessary tasks.

Thus there is need not only for thorough, up-to-date initial training but for continuing in-service training. This study provides a platform from which a system to provide such training can be established. The system includes a means of maintaining curriculum currency in the aviation mechanics schools in accordance with the technological requirements of the aviation industry. It also establishes a method that can guarantee maintenance of the emphasis of instruction at predetermined levels.

The research team greatly appreciates the assistance it received from the many participants in the aviation industry without whose help the survey questionnaire could not have been completed. The advice and guidance from the National Advisory Committee has also been singularly valuable to this research effort. The field analysts who collected the data are to be commended for their diligent efforts toward the successful completion of their work.

Our personal appreciation is hereby extended to Mrs. Travis Latham, editor, and our research support staff, Mrs. Dorothy Bossarte, Mrs. Elinor Shenkin, and Mrs. Karen Kent.

June, 1966 D. A.

Needs, Review, and Plans

Needs

A projection of the occupation of the aviation mechanic is a matter of concern to the aviation industry and the aviation mechanic schools. The growth of the industry is greatly dependent upon the skills and knowledge that the mechanic must acquire to meet the demands of an ever-evolving technology. Changes are occurring that are increasing the intricacy and complexity of aircraft repair, thereby directly affecting the training requirements for the mechanic. The necessity for updating the mechanic's training curriculum and maintaining his technical currency becomes increasingly evident.

THE MECHANIC

The aviation mechanics occupation requires skills and knowledge comparable with those of other highly skilled occupations. Many of the aircraft the mechanic encounters have the most sophisticated operating systems that have yet been developed, and the mechanic must remain current with the "state of the art." To service and repair aircraft, he uses precision tools and instruments in his daily work. Frequently working under time limitations, the mechanic must produce workmanship of the highest quality. The Mechanic's Creed states:[1]

> "Upon my honor I swear that I shall hold in sacred trust the rights and privileges conferred upon me as a certified mechanic. Knowing full well that the safety and lives of others are dependent upon my skill and judgment, I shall never knowingly subject others to risks which I would not be willing to assume for myself, or for those dear to me."

---

[1] Flight Safety Foundation, Inc., Aviation Mechanics Bulletin (New York: Flight Safety Foundation, Inc., 1953), p. 16.

The creed depicts the conscientious observance of air safety that is demonstrated by the thousands of aviation mechanics in the nation today.

William L. Lewis of the Cornell Guggenheim Aviation Safety Center describes the qualities needed of those employed in the aviation industry as...imagination, dependability, ingenuity, and...a burning desire to do the best possible job under any set of circumstances.[2] These words identify the major characteristics of the practicing aviation mechanic. Proud of his capabilities to use tools and his technical ability to analyze each new task he faces, the aviation mechanic has been the keystone of air safety.

The expanding role of commercial and general aviation as accepted, reliable modes of transportation is indicative of heightened national interest in aviation. The aviation mechanic is thus becoming more important to a greater number of people.

The rate at which the aviation mechanics occupation is developing and the lines along which the development is occurring will, to a large extent, be influenced by the increase in the number of aircraft in service. In the Occupational Outlook Handbook we find that:[3]

> The rapid growth anticipated in the amount of general aviation flying will lead to an increase in the number of planes. Therefore, an increase is expected in the number of mechanics employed in firms providing services and repair stations providing maintenance for the aircraft.

In the postwar years the airline industry has experienced phenomenal growth. This has been due to many factors, the more important being the increased carrying capability of modern aircraft coupled with the dependability of maintenance and operation of these aircraft. G. E. Keck, president of United Airlines, writes in the June, 1966, issue of the Mainliner magazine:[4]

---

[2] Ibid., p. 14

[3] U.S. Department of Labor, Occupational Outlook Handbook, 1966-67 edition (Washington, D. C.: U.S. Government Printing Office, 1965), p. 634.

> About seven years ago the U. S. scheduled air Carriers began introducing jet aircraft...The airlines at that time employed approximately 160,000...The airlines now have 200,000 on their payrolls...Over the next five years airline employment is expected to increase by 50,000.

The increased aviation activity in large general aviation and the airlines is creating a growing demand for skilled mechanics. The input of young mechanics is low, however, as has been recently reported in the Federal Aviation Agency Statistical Handbook of Aviation.[5] In 1965 less than 0.5 percent of the certificates were held by the 16- to 19-year-old mechanics; 2 percent were held by the 20- to 24-year-old mechanics, and 7 percent were held by the 25- to 29-year-old mechanics. All aviation mechanics that were 34 years of age or younger represented only 22 percent of the total number of certificated mechanics. Additionally, it has been predicted that the number of mechanics leaving the occupation annually because of retirement will increase from about 1,200 in 1964 to about 3,300 in 1980.[6] If, as these statistics suggest, a trend should develop whereby fewer mechanics are being trained to replace those leaving the industry, a situation of national concern will exist.

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[4] G. E. Keck, "Technology and Employment," Mainliner, Volume 10, Number 6 (June, 1966).

[5] Federal Aviation Agency, FAA Statistical Handbook of Aviation, (Washington, D.C.: U.S. Government Printing Office, September, 1965), p. 69.

[6] Federal Aviation Agency, Report of the Aviation Human Resources Study Board on Manpower Requirements of the Civil Aviation Industry, (Washington, D.C.: 1964), U.S. Government Printing Office, p. 11.

Aviation mechanic schools have for many years been an integral part of the nationwide vocational education program. Throughout the United States these schools have been engaged in training students for employment as certificated aviation mechanics.

In 1965 there were 69 aviation mechanic training programs approved by the Federal Aviation Agency in operation in the nation.[7] Sixty-six of these programs are operated in either the private or public schools and, in addition, two programs are operated in correctional institutions and a third is specifically concerned with the training of missionaries. The schools are located in five geographic regions of the nation. Fifteen are in the eastern region, 12 are in the southern region, 17 are in the central region, 25 are in the western region (of which 17 are in California), and one is in the Pacific region in Honolulu. In contrast, there are 1,180 certificated pilot flight and ground schools in operation in the United States.[8]

There are four distinct types of programs in which an individual may enroll and receive his Airframe and/or Powerplant license. These are the high school and adult trade programs, the vocational and technical programs, the two-year Associate in Arts Degree program, or the four-year Baccalaureate Degree program. Although the Federal Aviation Agency has provided guidelines for the training of aviation mechanics, there is a great disparity between the instructional programs of the various schools. Wide differences exist among the school programs in entrance requirements, length of courses, numbers of hours of instruction, facilities, etc. The schools have attempted to exceed the Federal Aviation Agency requirements and to adjust their instructional activities in fulfilling the aviation industry needs in their local communities. Representatives of the aviation industry have at times contended that distinct courses for training an airline mechanic and a general aviation mechanic should be offered in the schools. Despite the differences that exist in school programs, the schools have in most cases provided comprehensive training for their students. However, with the rapid technical changes, as well as the changes in emphasis of the skills and knowledge required by aviation mechanics, it is becoming more apparent that a core curriculum must be developed that will guarantee depth of training where needed without over-training in areas that are becoming obsolete.

---

[7] Statistics concerned with mechanics schools appearing in this section are taken from Aviation Technician Education Council, 1965 Survey, Federal Aviation Agency Approved Mechanic School Programs (Pittsburgh: ATEC, 1964), pp. 1-21.

[8] Federal Aviation Agency, List of Certificated Flight and Ground Schools, Advisory Circular, AC No. 140-2B (Washington, D.C.: U.S. Government Printing Office, January 1, 1966)

The programs within the schools have not been static. There has been a steady increase in enrollment and a definite trend toward increasing the hours of course instruction. There has also been an expansion of new instructional space. During the years 1964-65, 75,000 square feet of new instructional area became available.[9]

The need for aviation mechanics indicates that aviation mechanic schools will have to train a greater number of mechanics. While they are training these men, the schools will also have to continually review their programs. These revised programs will have to be designed with the full realization that the aviation mechanic's education does not cease upon his graduation. The schools will have to conduct many additional classes to assist the mechanic in upgrading his skills during his employment in the aviation industry.

---

[9] Op. cit., Aviation Technician Education Council, 1965 Survey, p. 21.

In most cases the schools have employed teachers who have had many years of work experience in the aviation industry and who have attempted to remain current with the ever-changing aviation industry. These instructors will have to develop better ways of teaching mechanics how to work within reasonable time limits, and the instruction should be given without neglecting the learning processes. It is imperative that acceptable "return to flight" standards of workmanship be developed by the students.

The challenge for the training and retraining of aviation mechanics is placed squarely before the schools and industry. Both have proven that they can provide the training unique to their objectives. The need now confronting industry and the schools is for the establishment of a basic curriculum that is sufficiently flexible to allow currency with the aviation industry and to provide increased teaching effectiveness.

Review

After 1938, when the Civil Aeronautics Act was passed and the Civil Aeronautics Administration formed, training guidelines were developed by the Civil Aeronautics Administration to identify the tasks an aviation mechanic is customarily expected to perform. Included in these guidelines were specified standards of training and lists of equipment deemed appropriate to accomplish the training objectives. Today, as in the past, the Federal Aviation Agency, with the cooperation of the aviation industry and the aviation schools, is effecting changes in these guidelines whenever the need to make such changes is properly supported.

However, no coordinated program to develop, disseminate, or implement a basic aviation mechanics curriculum has been initiated to meet the changing demands and needs of the aviation industry on a national scale. There has been in fact no nationwide investigation into the mechanic's training needs, beyond the local interpretation and adaptation of the broad Federal Aviation Agency guidelines.

Few studies of any magnitude have been made of the training for the occupation of the aviation mechanic. One study that was prepared is the Report of the Aviation Human Resources Study Board on Manpower Requirements of the Civil Aviation Industry published in 1964 by the Federal Aviation Agency.[10] This study focused particular attention on the manpower and training status of the aviation mechanic.

> Aviation mechanics' work opportunities have been overlooked during the past decade as the aerospace industry and other users of skilled aviation mechanics concentrated on the space drive and drew upon the existing World War II reserve of trained men. As a result, the attention of many educators and of career counselors was diverted so that the output of men trained in the mechanical arts has steadily declined. Since the airlines and the remainder of the civil aviation industry were drawing their high skill and certificated mechanics personnel from the military trained reservoir, the need for training schools and long-range planning was understandably delayed or ignored.

This report continues:

> The mechanic trained personnel released annually from the military services cannot be viewed as a

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[10] Federal Aviation Agency, Report of the Aviation Human Resources Study Board on Manpower Requirements of the Civil Aviation Industry (Washington, D.C.: U.S. Government Printing Office, 1964), p. 68.

> readymade resource of aviation mechanics for civil aviation employers. This group has received varying degrees of training in a specialty or semiskilled category. Substantial retraining or even total new skill training is required before they can qualify for certification by the Federal Aviation Agency.

In 1965, a comprehensive study of the occupation of the aviation mechanic in California was published cooperatively by the Bureau of Industrial Education, California State Department of Education and the Division of Vocational Education, University of California, Los Angeles.[11] The University of California, Los Angeles, research group included David Allen, Richard Lano, and Norman Witt. From this study, a "common core curriculum" for the aviation mechanic in California was suggested. The technical knowledge and manipulative skill levels were identified and from these followed the appropriate teaching levels and methods that assisted in measuring the degree of proficiency attained.

The present nationwide study of the occupation of the aviation mechanic, incorporating the same data-gathering instrument and the same design criteria, was developed from the California study. The data gathered in the California study have been incorporated in the national study to provide expanded survey coverage.

Plans

By the time the California portion of the Study of the Aviation Mechanics Occupation had been concluded, it had become apparent that expansion of the survey to other regions of the continental United States would provide vital additional data to identify the tasks and training needs of the mechanic. A national study of the occupation therefore would assist in the identification of core relationships for curriculum development. The study is so designed that it would not restrict the flexibility needed for specialized tasks in local communities. The overall objective of this study is to assist the schools in more nearly satisfying both the training requirements of the Federal Aviation Agency and the employment needs of the industry.

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[11] David Allen, Richard Lano, and Norman Witt, A Study of the Aviation Mechanics Occupation (California State Department of Education and the University of California, Los Angeles, 1966).

The national survey was undertaken to provide data for the accomplishment of three objectives:

1) To investigate the technical knowledge and manipulative skills of aviation mechanics as required by the aviation industry.
2) To identify a core curriculum for the training of aviation mechanics.
3) To identify the scope of training offered by industry.

STRUCTURE OF THE STUDY

The nationwide research study to explore the occupation of the aviation mechanic was designed to survey airlines and both large and small general aviation companies throughout the continental United States. Small general aviation, for the purposes of this study, is defined as companies that employ five or fewer aviation mechanics. Only aviation companies employing Federal Aviation Agency certificated airframe and/or powerplant mechanics were included in the study. Aviation industrial concentrations are generally situated in large urban areas; however, it was essential to include less populated areas in the study in order to obtain data that might be unique to each particular segment and locale of the industry. Following an aviation density study of the United States, 26 states and the District of Columbia were selected for representation in the study.

ASSUMPTIONS FOR THE STUDY

The study is based on two assumptions: (1) that all manipulative skills require some degree of technical knowledge but not all technical knowledge requires manipulative skill, and (2) that all training in aviation mechanic schools will develop the mechanic's manipulative skills so that he will be able to perform work of return to flight quality.

SURVEY INSTRUMENT

The first questionnaire developed for the study in California was a complex instrument. The instrument was redesigned and validated through a "dry run" in industry for the survey in California.[12] This survey instrument was reviewed by the National Advisory Committee and without change was used in the national study.

The questionnaire was designed so that the collected data could be introduced directly into the aviation mechanics school curriculum. The subtopics studied, each of which represented a task performed by an aviation mechanic, were written in behavioral terms.[13] A code system indicating the aviation mechanic's activities, which was used by those being interviewed, was designed so that varying levels of educational attainment required to perform the various tasks could be identified.

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[12] Allen, Lano, and Witt, A Study of the Aviation Mechanics Occupation, p. 7.

[13] The word "subtopic", which denotes a behavioral task, is used throughout this report to refer to any of the 507 subtopics used in the study.

This identification could then be used to develop teaching levels and to test to determine if the teaching level had been attained.

The nationwide survey was designed to provide answers to five specific questions:[14] (1) the number of men performing each task, identified in the questionnaire as "Men"; (2) the frequency at which these men performed the task, identified as "Freq"; (3) the level of technical knowledge required to do each task, identified as "T/K"; (4) the conditions under which the return to flight manipulative skills had to be performed, identified as "M/S"; and (5) the depth of training conducted by industry, identified as "IND."

The identification of levels of technical knowledge was based on the classification of educational objectives developed by Benjamin S. Bloom and his colleagues. Five levels of technical knowledge were assigned to fit the aviation mechanics occupation. These levels were: (1) knowledge (the ability to recall facts and principles, to locate information, and to follow directions); (2) comprehension (the ability to restate knowledge or to interpret information and drawings needed in performing a job); (3) application (the ability to apply principles or transfer learning to new situations); (4) analysis (the ability to reduce problems to their parts and detect relationships between these parts, such as breaking down a malfunction into its fundamental parts in order to troubleshoot); and (5) synthesis (the ability to assemble the knowledge of principles and procedures needed to complete repairs and to construct new or substitute parts). Manipulative skill, which was under the assumption that established the level of workmanship, was studied in relation to the conditions under which a mechanic necessarily performs his duties, such as working under pressure of time and planning his job before performing the job.

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[14] Allen, Lano, and Witt, op. cit., pp. 8-10

FINAL FORM OF QUESTIONNAIRE

A sample of the questionnaire's layout follows.

Woodwork		Men	Freq	T/K	M/S	IND
1.	Building a rib					
2.	Building a wing section					
3.	Making a spar splice					
4.	Other tasks					

The answer code system and method of responding to each item in the questionnaire can best be explained by the following samples concerning the fueling of a light aircraft.

Column 1 (Men)

The number of men engaged in performing a given task.

Example: If two men in your charge are responsible for fueling Piper Cubs, you should enter the figure "2" in Column 1 as shown. (Leave the remaining four column spaces blank.)

		Men	Freq	T/K	M/S	IND
1.	Fuel Piper Cub	2				

Column 2 (Freq)

The frequency of use as applied to your specific situation.

The code system:

1. Used annually
2. Used semi-annually
3. Used monthly
4. Used weekly
5. Used daily

Example: If the two men in the previous example fuel Piper Cubs every day, you should enter the figure "5" in Column 2 as shown.

		Men	Freq	T/K	M/S	IND
1.	Fuel Piper Cub	2	5			

Column 3 (T/K)

A description of the kind of technical knowledge required of your men to perform a particular task.

The code system:

1.	Knowledge	ability to locate information and to follow directions
2.	Comprehension	ability to interpret information and drawings needed in performing a job
3.	Application	ability to apply principles and to transfer learning to new situations
4.	Analysis	ability to break a malfunction into its fundamental parts in order to troubleshoot
5.	Synthesis	ability to put together knowledge of principles and procedures to complete repairs and to construct new or substitute parts

Example: If the same two men mentioned in the preceding examples must know how to find and follow the directions for fueling a Piper Cub, you should enter the figure "1" in Column 3 as shown.

	Men	Freq	T/K	M/S	IND
1. Fuel Piper Cub	2	5	1		

Column 4 (M/S)

The conditions under which the manipulative task is performed. The code system:

1. Not needed
2. Reasonable time limit, no advanced job planning required
3. Reasonable time limit and requires advanced job planning
4. Time critical but no advanced job planning required
5. Time critical and requires advanced job planning

Examples: If your two men have a reasonable amount of time in which to fuel the Cub and need not plan the job, you should enter the figure "2" in Column 4 as shown.

	Men	Freq	T/K	M/S	IND
1. Fuel Piper Cub	2	5	1	2	

Column 5 (IND)

The degree of training offered in your industry.
The code system:

1. No training offered
2. Familiarization only offered
3. Basic training offered
4. Detailed training offered

Example: If your organization offers detailed training in the fueling of a Cub, you should enter the figure "4" in Column 5 as shown.

	Men	Freq	T/K	M/S	IND
1. Fuel Piper Cub	2	5	1	2	4

Each task was rated as in the above example. The interviewee answered those items with which his work experience directly related. The research analyst was available to the interviewee for consultation to help clarify the material as needed. In addition to completing the questionnaire, each interviewee entered on an information sheet his name, job title, date of interview, name, address, and type of company by which he was employed (airline, line; airline, overhaul; large general aviation; or small general aviation); number of mechanics that he supervised directly; type of work he performed, and the number of years he had worked as a mechanic. Each interviewee completed those portions of the questionnaire that related directly to the work he was doing.

Thus, equipped with a questionnaire to obtain answers to the five key questions: number of men performing each task, frequency at which the task is performed, level of technical knowledge required, conditions under which manipulative skill is performed, and depth of industry training provided, the research staff was ready to begin implementing the survey.

Implementation, Action, and Results

Implementation

Before the field work of the survey could begin, areas to be surveyed had to be selected. Aviation directories and aviation publications from governmental and commercial sources were searched for the locations of aviation companies that performed airframe, powerplant, propeller, radio, instrument, and accessory work. The information gained from these sources was supplemented by various Federal Aviation Agency district offices throughout the country, which assisted by providing the names of additional companies that employed certificated mechanics. Certain regions of the United States were identified as those in which occurred the heaviest concentrations of airline and general aviation activity. An industry density pattern was then plotted for the entire country and from this six large geographic areas evolved. The states and the survey areas they formed are listed below.

Area 1* - Idaho, Oregon, Utah, Washington
Area 2 - Colorado, Kansas, Oklahoma, Texas, western Missouri
Area 3 - Illinois, Iowa, Minnesota, eastern Missouri
Area 4 - Florida, Georgia, North Carolina, South Carolina
Area 5 - Maryland, Michigan, Ohio, Pennsylvania, Washington, D.C.
Area 6 - Connecticut, Massachusetts, New Jersey, New York

Fig. 1. Research Areas

***California was excluded because it was previously surveyed, and the California data is included in the national survey.**

The names of 285 airlines and general aviation companies appeared in the first compilation. An additional 162 companies were added in accordance with information from the Federal Aviation Agency district offices and flight standards branch offices in each survey area. Upon a closer examination, 61 of the 285 companies first compiled were found unsuited to the purposes of the study. These were removed from the list because they either (1) employed no airframe and powerplant mechanics, (2) had discontinued aviation repair operations, (3) had merged or undergone other business reorganization, or (4) were no longer in business. A total of 386 companies comprised the final list.

SURVEY ANALYSTS

Six survey analysts were employed to conduct the survey. These analysts were professional men, oriented in technical or mechanical areas, selected by the administrators of the research staff on the basis of such factors as maturity and ability to meet people easily. Another essential characteristic of those chosen was an overriding interest in achieving the objectives of the survey. The men who were employed resided in or close to the areas to which they were assigned. A list of the analysts and their regional assignments is contained in Appendix B.

The analysts were instructed in the objectives of the study, the use of the questionnaire, the techniques to be used during the interviews, and the general procedures to use in carrying out the survey. Training sessions were held with each of the analysts at his home city, and these were followed up during the early phases of the survey through frequent contacts to make certain each analyst continued to show a thorough understanding of the survey methodology.

SURVEY ADMINISTRATION

The survey was administered by the University of California, Los Angeles, research staff concurrently in all six areas, and the survey activities of each analyst were supervised by means of two devices: an instruction manual containing administrative guidelines and a supply of interview record forms for use in keeping a log of the analyst's visits to the companies.

The manual contained certain general information, such as instruction for correct completion of the questionnaire, methods to use in preparing for and conducting the interviews, instructions for completing the interview forms, and a list of coding designations for Federal Aviation Agency certificated repair stations. Each manual also contained the following information applicable only to the area it governed: copies of letters of introduction to the companies to be contacted, copies of letters to various Federal Aviation Agency flight standards branch chiefs and maintenance inspectors to introduce the survey and the analyst, a directory of Federal Aviation Agency offices and personnel, a list of companies and personnel to contact, an area route and mileage map, and a full set of interview record forms in duplicate.

The analysts were instructed to use these interview record forms to log the dates of contact, persons contacted, number of airframe and powerplant mechanics employed by the companies, running total of mileage, and general comments. As each form was completed, the analyst was to air mail a duplicate to the University of California, Los Angeles, research office. In addition, correspondence concerning the study received at the research office and considered pertinent to the field was forwarded to the analysts.

Overall supervision of the survey was maintained successfully not only as the interview forms were received from the analyst but also as the analysts maintained telephone contact with the research headquarters at specified points along the route. The need for long distance telephone communication was in reality minimized by use of the interview forms.

NATIONAL ADVISORY COMMITTEE

One of the most important phases of the national study was the formation of the National Advisory Committee. The committee consisted of individuals representing private and public aviation mechanic training schools, small and large general aviation companies, airlines, the United States Department of Labor, and the Federal Aviation Agency. This distribution of background was selected to provide a broad spectrum of knowledge that would assist the research team in achieving the objectives of the study. A list of National Advisory Committee members is included in Appendix A.

The first meeting of the National Advisory Committee took place at the Federal Aviation Agency Aeronautical and Space Center, Will Rogers Field, Oklahoma City, Oklahoma, on November 17, 1965, and was attended by the research staff and all members of the committee. During this meeting the committee was briefed on the goals of the study and of the survey completed in California. The committee was asked to review the survey instrument and the analyst's manual. It was at this meeting that the survey instrument was approved.

The committee recommended that a substantiating cross-check be made of all aviation companies identified within the established six areas. It was also recommended that the research survey analysts contact local

Federal Aviation Agency personnel in order to identify additional aviation companies that employ airframe and powerplant mechanics.

The committee established two parameters for the display of data for the national study. These were:

1) The frequency with which mechanics performed each task should be considered as "high" or "low." Tasks performed less frequently than monthly should be considered as "low," to be shown by the letter "L"; those performed monthly or more frequently should be considered as "high," shown by the letter "H."

2) Survey statistics relating to the number of mechanics performing each task should be grouped and displayed in descending order. The subtopics should be arranged under each topic in the order of percent of men performing the task. Thus, those tasks performed by 10 percent or more of the men in all four categories were listed first and the remainder arranged as "5 to 10 percent," "2 to 5 percent," and "Less than 2 percent," corresponding to the number of men performing the task in each of the four categories.

Ways of disseminating information on the survey were explored. All committee members agreed to present information about the survey and the study at conventions they would attend, as well as through correspondence and local press releases. (Committee members representing the airlines later contacted the Air Transport Association and through that organization informed airline companies of the survey.) A press release describing the national study was prepared by the research office and released through the university public relations office for national distribution.

The committee agreed upon a request submitted by Howard Rosen, United States Department of Labor, for a subsample study to be made to obtain information on how recently the mechanics had received in-service training in current industry practices. The subsample was to have a distribution of approximately 500 questionnaires. This subsample study is discussed in detail under "Industry Efforts" in the "Redirection" section of this report.

Action

DATA COLLECTION

The field survey of the six areas of the United States began on December 1, 1965, and was completed during the first week of March, 1966. At each of the 386 companies contacted, qualified personnel reviewed the survey instrument and received instruction from the analyst for its completion. Wherever it was possible, the analyst mailed the completed questionnaire to the research office immediately following the conclusion of the interview. In other cases when the questionnaire was not completed during the interview, and the analyst was satisfied that the person or persons answering the questionnaire understood it sufficiently to work without further direction, he left it at the company for completion. The person interviewed agreed to return the completed survey material by mail to the research office.

Participants were very cooperative and expressed considerable interest in the purposes of the survey. Approximately 55 percent of the instruments were returned within a few days of an interview. To ensure return of the remaining questionnaires by the earliest possible date, a

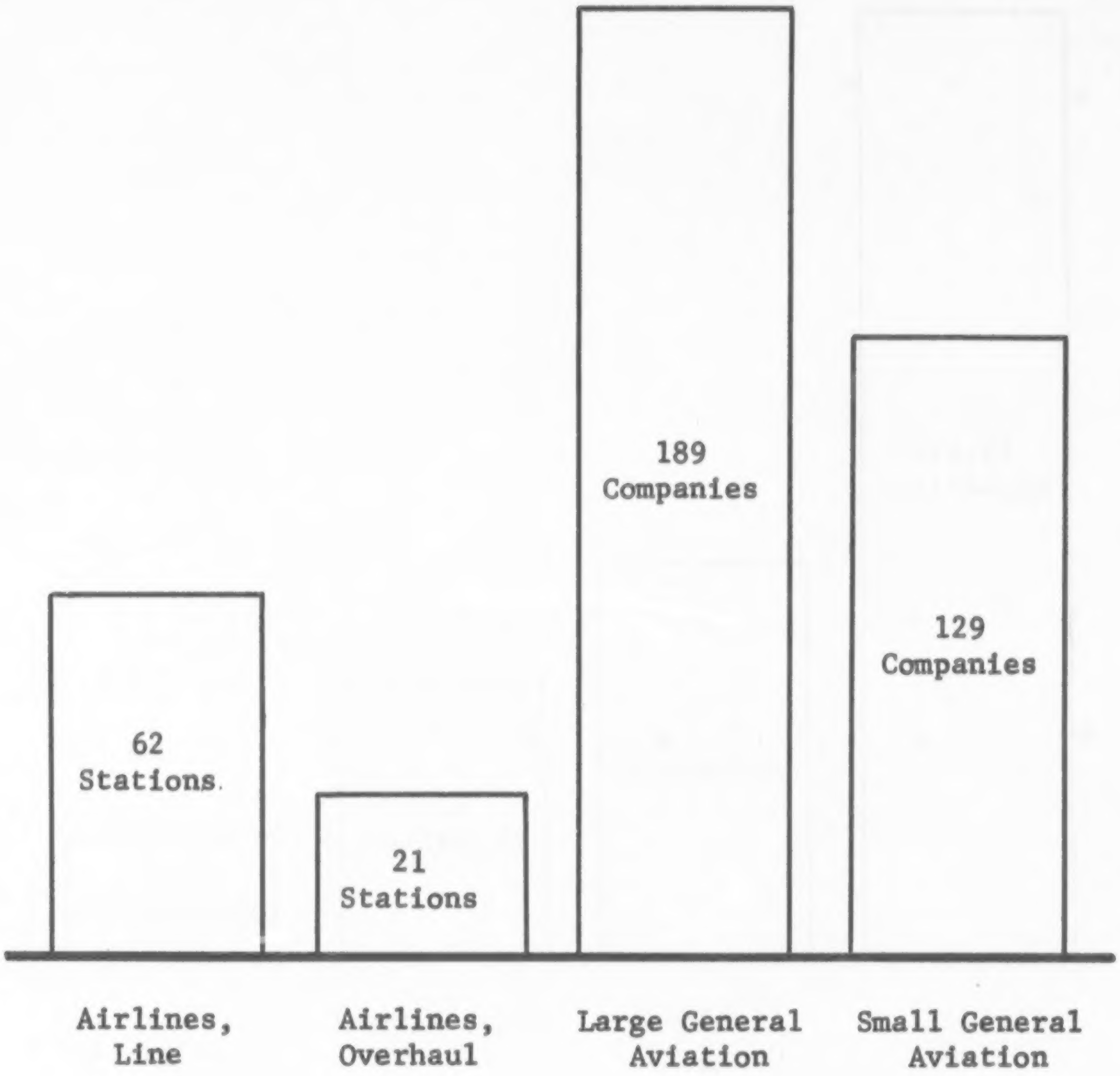

Fig. 2. Distribution of 401 companies and stations responding to the survey.

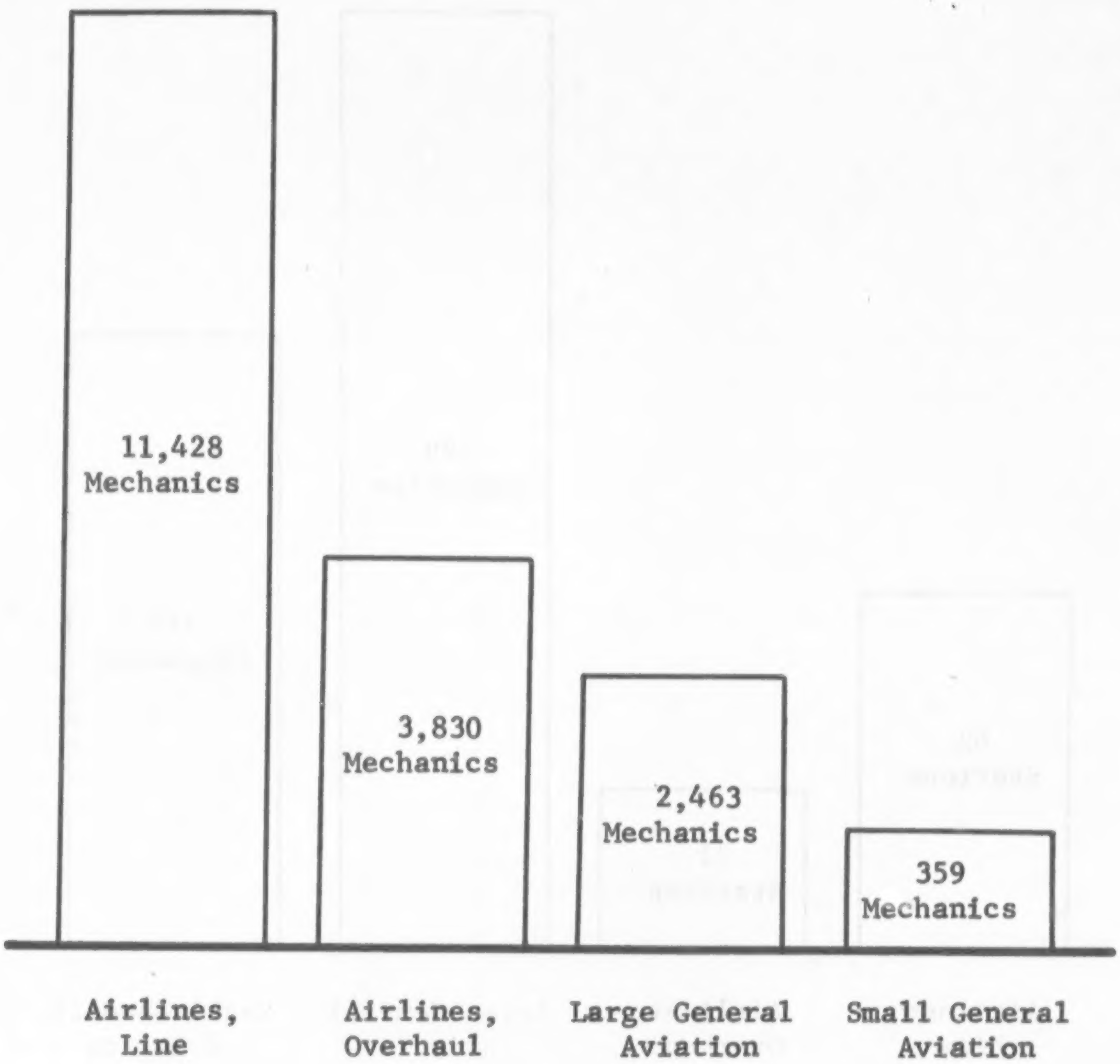

Fig. 3. Distribution of 18,080 certificated airframe and/or powerplant mechanics included in each industrial category reported.

vigorous follow-up program was pursued. First, a letter of reminder was sent from the research staff directly to the individuals within each company responsible for the return of the questionnaire. Then, whenever scheduling permitted and visits were deemed appropriate, the analysts revisited the companies to encourage their response. Finally, a telephone call was made to the responsible company personnel by either the research staff or by the analyst in the area to advise them that the questionnaire must be received at the research office by March 20, 1966, if it was to be prepared for computer tabulation on March 29 as scheduled. As a result of these procedures, 25 percent more companies responded with completed questionnaires.

The national response in numbers of companies and stations is presented in Fig. 2, which includes the companies that responded in the California survey. A total of 485 companies were contacted in both surveys and 401 of these companies responded, representing an 82 percent response. A list of all responding companies is shown in Appendix C.

As the questionnaires were received, the research staff reviewed each completed instrument for possible evidence of misunderstanding or misinterpretation of instructions. If some doubt existed in regard to any item, the individual who completed the questionnaire was contacted by telephone or revisited by the analyst and the item in question was clarified. Problems of this nature were found to have occurred in relatively few cases.

Each questionnaire was then assigned a code number that identified the industrial category to which it belonged and the geographic area from which it originated. The data collected was separated into four major industrial categories: airline line stations, airline overhaul stations, large general aviation companies, and small general aviation companies.

Data collected for each of the subtopics were key punched on IBM cards. By means of computer programming, the information was stored on tape and then processed through an IBM 7094 computer. The final program consisted of a computer program developed by Edwin W. Banhagel of Hughes Aircraft Company.[15] The resultant information was printed out for all four categories, which were arranged and programmed so that the final computer print-out produced the data shown in Tables 1 through 52 of this report.

CURRICULUM DEVELOPMENT PARAMETERS

The tabulated data shown in this report were presented in the same format to the National Advisory Committee at their second meeting, which was held at Purdue University in April, 1966. At this meeting, the members set the parameters that provided criteria for establishing a core curriculum. These parameters were used to identify the subtopics to be included in the core curriculum, and to establish the teaching level to which each subtopic should be taught.

The first parameter identifying the subtopics that should be included in the curriculum was based on the percent of mechanics performing tasks in the aviation industry. From this parameter all tasks performed by more than 2 percent of the mechanics in at least three of the industrial categories were to be included in the core curriculum. With this reference point, the committee reviewed all the subtopics. Those that failed to meet this standard were recommended for deletion from the core curriculum; those that did meet this standard were recommended for inclusion in the core curriculum.

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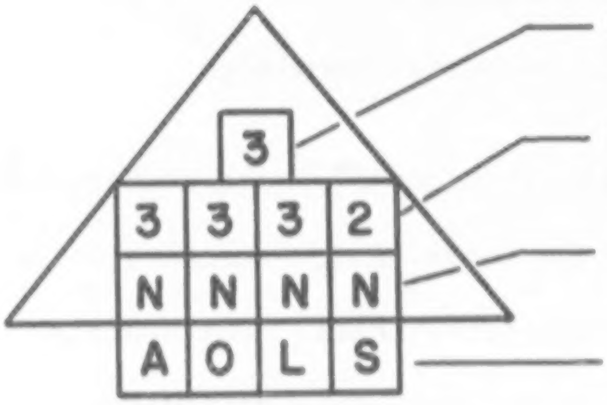
[15] The research staff gratefully acknowledges the services performed by Mr. Banhagel and the fine cooperation received from Hughes Aircraft Company. A detailed description of the program can be found in Allen, Lano, and Witt, op. cit., pp. 159-64.

The second parameter established a guideline for determining the depth of the training by teaching levels in relation to the consensus level of technical knowledge. Figure 4 illustrates the steps taken to establish a consensus number for the frequency of distribution of technical knowledge for each subtopic.



CONSENSUS NUMBER
(determined by Advisory Committee)

RESULTANT NUMBERS
(determined by computer tabulation)

SURVEY RESPONSES
(obtained from the industry)

INDUSTRIAL CATEGORIES

Fig. 4

Beginning at the base of the diagram, the letters A, O, L, and S identify the industrial categories--airline line stations, airline overhaul stations, large general aviation companies, and small general aviation companies--that responded to the survey. The letter N in each square of the next row represents the raw data gained from the survey responses. The numbers 3, 3, 3, and 2 in the third row represent the resultant frequency distribution numbers for the industrial categories as totalled and printed out by the computer. The single number 3 at the top of the diagram represents the consensus number designated by the advisory committee, based on their evaluation of the frequency numbers. The three basic criteria used by the committee to derive the consensus number for this and other frequency number combinations is explained in the following paragraphs.

	T/K			
	A	O	L	S
Subtopic 1	2	3	3	3
Subtopic 2	3	3	3	4
Subtopic 3	4	4	3	3

Fig. 5. Parameter: frequency of technical knowledge

Figure 5 is a display of typical distributions of these numbers for each subtopic that may have occurred in the industrial categories as accumulated by the computer tabulation of raw survey data. For example, Subtopic 1, Fig. 5, shows a combination of "2333." This combination might have occurred as "3233," "3323," or "3332." The order in which these numbers were distributed was unimportant inasmuch as the consensus number resulting from any of these combinations would be the same.

In the first criterion, a combination of four numbers formed by three similar numbers and one lower number, as in the case of Subtopic 1, was considered equal to the three higher numbers. The number "2333" was thus considered to have the value of "3333." This combination was evaluated as a single number representing the level of technical knowledge

2

for this subtopic. The numerical value of "3333" then became "3," which is the consensus number equivalent to the application level in technical knowledge.

In the second criterion, a combination of four numbers formed by three similar numbers and one higher number, as in the case of Subtopic 2, was considered equal to the three lower numbers. The number "3334" was thus considered to have the value of "3333," with a consensus number of "3." The one higher number appearing in this combination was considered to indicate the feasibility of providing extension training at the fourth technical knowledge level, where geographic location or industrial needs warrant.

In the third criterion, the median number was considered when mixed combinations of numbers occurred. A numerical distribution whose average value was 3.50 or less was considered a "3333," or "3," and a numerical distribution whose average value was 3.51 or more was considered a "4444." This combination then became a "4," the analysis/synthesis level in technical knowledge. In Fig. 5 the distribution "4433" is seen to have occurred for Subtopic 3. This group of numbers was considered to equal 3.50, which was evaluated as "3." If this subtopic had received a number distribution of "5433," for example, the group of numbers would have had an average value of 3.75 and would thus have been considered equal to "4." However, the committee agreed that, in the case of mixed number combinations, the level of instruction could be set by each school in accordance with local industrial needs and local advisory committee recommendations. A distribution of "4433" could then be adjusted to "4" as indicated locally, or remain at "3" as recommended by the National Advisory Committee.

In addition to the two parameters for identifying subtopics to be included in the core curriculum and depth of training, two additional criteria were established to assist in making teaching depth judgments. One dealt with the depth of training given in industry, as well as the type of equipment on which the training was given. The second criteria was based on the conditions under which manipulative skills are being performed by the mechanics in the industry under time pressure. Thus, with guidelines for identifying subtopics and establishing teaching levels, the committee was able to review the entire data and make the recommendations appearing with each of the Tables 1 through 52. The depth of training, the instructional settings, and the testing levels are described fully in the following discussion under "Teaching Levels."

TEACHING LEVELS

The National Advisory Committee was guided by four established levels of instruction to which any subtopic in the core curriculum could be taught. Each teaching level was given equivalent testing levels, "Knowledge," "Comprehension," "Application," and "Analysis/Synthesis," to determine whether the training had been achieved. In addition, four instructional settings for teaching airframe and powerplant subtopics (Condition I) and four instructional settings for teaching subtopics in related subjects, such as mathematics and physics, (Condition II) were established.

The teaching levels for airframe and powerplant instruction are:

Level	
1	Knowledge of sources of information and ability to follow directions
2	Ability to interpret information and drawings needed in performing a job

3 Knowledge and understanding of principles and processes and ability to apply them to specific situations

4 Ability to separate a malfunction into its fundamental parts in order to troubleshoot, and ability to put together knowledge of principles and procedures to complete repairs, including construction of new or substitute parts

The description of the instructional setting for airframe and powerplant instruction and testing for each teaching level is as follows:

Instructional Setting (Condition I)

A - Instructional Setting A should be an orientation lesson. A subtopic should be mentioned in a lecture but there should be no manipulative instruction. Testing should be at the knowledge level.

B - Instructional Setting B should be an overview of the subtopic, including both technical and manipulative training. Testing should be at the comprehension level.

C - Instructional Setting C should present detailed instruction so that the student can, with additional review, recall the information readily later when he has been employed. Testing should be at the application level.

D - Instructional Setting D should train in depth, in both technical and manipulative skills, to facilitate transfer of learning with minimum difficulty. The student, when later employed, should be able to start a task with minimal instruction. Testing should be at the analysis/synthesis level.

In related subjects, such as mathematics and physics, four instructional settings were established:

Instructional Setting (Condition II)

E - Instructional Setting E should be an overview. Testing should be at the knowledge level.

F - Instructional Setting F should include basic, workable skills in the fundamentals of the subtopic. Testing should be at the comprehension level.

G - Instructional Setting G should be presented in enough detail so that recall can be accomplished with little additional training.

Instructional Setting (Condition II) - continued

Specific safety information should be strongly emphasized. Testing should be at the application level.

H - Instructional Setting H should train in depth to facilitate direct transfer of learning. It should include the specific information required to ensure safety and should result in a complete mastery of the subject so that a return to flight attitude can be maintained by the mechanic. Testing should be at the analysis/synthesis level. Great stress should be placed on developing a positive attitude toward safety in the mechanic so that he carries this attitude through his productive years.

The relationships among these four major headings are shown below.

TEACHING LEVELS	INSTRUCTIONAL SETTING (Condition I)	INSTRUCTIONAL SETTING (Condition II)	TESTING LEVELS
1	A	E	Knowledge
2	B	F	Comprehension
3	C	G	Application
4	D	H	Analysis/Synthesis

Several times the National Advisory Committee changed the instructional setting but did not change the teaching level. For example, it was occasionally recommended that a subtopic being taught to Teaching Level 2 should provide an overview of the subtopic with technical training included; however, it was recommended that manipulative training be deleted. Testing should continue at the comprehension level.

Results

On the following pages are the tables presenting all of the data collected by the survey. Each table represents a major topic heading and shows the subtopics performed by the aviation mechanic. The subtopics are arranged in descending order from most frequent to least frequent, as determined by the percent of mechanics performing that task.

KEY TO TABLES

Data is presented in five columns with the headings identified as "N," "F," "T," "M," and "I," shown in the example below.

	N	F	T	M	I

The headings represent the following:

N............Percent of mechanics performing the task

F............Frequency with which the task is performed

T............Technical knowledge required to perform the task

M............Manipulative skill required to perform the task

I............Industry training offered

Each of the preceding columns is divided in accordance with the four industrial categories, identified by "A," "O," "L," and "S," shown in example below:

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S

The categories represent the following:

A............Airline line stations

O............Airline overhaul stations

L............Large general aviation companies

S............Small general aviation companies

Data applicable to the "N" column in example below is represented by the following symbols, which indicate the percentage of mechanics performing each task:

+	Tasks performed by 10 percent or more of the mechanics in that industrial category
$	Tasks performed by 5 to 10 percent of the mechanics in that industrial category
-	Tasks performed by 2 to 5 percent of the mechanics in that industrial category
No symbol	Tasks performed by less than 2 percent of the mechanics in that industrial category

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
	$	–	+	+																

Data applicable to the "F" column, in example below, is represented by the following letters indicating the frequency with which the task is performed:

L	The job is performed semi-annually or less often (low frequency)
H	The job is performed daily, weekly, or monthly (high frequency)
No letter	The task is not performed

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
	$	-	+	+	H	H	L	H												

Data applicable to the "T" column in example below is represented by the following numbers indicating the technical knowledge required to perform a given task:

1 - Knowledge
2 - Comprehension
3 - Application
4 - Analysis
5 - Synthesis

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
	$	-	+	+	H	H	L	H	3	3	3	3								

Data applicable to the "M" column in example below is represented by the following numbers denoting the manipulative skill required by the task:

1 - Not needed
2 - Reasonable time limit, no job planning required
3 - Reasonable time limit, job planning required
4 - Time critical, no job planning required
5 - Time critical, job planning required

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
	$	-	+	+	H	H	L	H	3	3	3	3	3	4	3	3				

Data applicable to the "I" column in example below is represented by the following numbers denoting the degree of training offered by industry:

1 - No training offered
2 - Orientation or familiarization training offered
3 - Basic or general information training offered
4 - Training in depth offered

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
	$	-	+	+	H	H	L	H	3	3	3	3	3	4	3	3	3	4	2	3

Beginning with Table 44, the "M" column is replaced by the "A/S" column, as in example below. The applicable "A/S" data is represented by the following numbers denoting whether accuracy and/or speed is required in performing each task:

1 - The task must be performed with accuracy
2 - The task has to be done with accuracy and speed
(Note: Table 52, "Ethics and Legal Responsibilities," does not have an "M" or "A/S" column, because neither of these factors is applicable to the topic.)

	N	F	T	A/S	I
	A O L S	A O L S	A O L S	A O L S	A O L S
	$ – + +	H H L H	3 3 3 3	1 2 1 1	3 3 2 3

Note: When a blank appears in all 5 columns in any one industrial category, it means the task is not performed by that industrial category.

Adjacent to each table is (1) overview of work performed by an aviation mechanic (2) the principal findings of the survey (3) the recommendations of the National Advisory Committee. All subtopics studied are listed so that schools can evaluate the results and the recommendations of the National Advisory Committee as a basis for possible inclusion in their curriculum of some of the subtopics not recommended by the National Advisory Committee.

TABLE 1. WOODWORK

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
MAKE RIB REPAIR			$	+			L	L			3	3			3	3			3	3
USE GLUES AND CLAMPS			$	+	H		L	L	3		3	3	3		3	3	3		3	3
IDENTIFY WOOD DEFECTS			$	+							3	3			2	3			3	3
BUILD A RIB			-	+			L	L			5	3			3	3			3	3
BUILD WING SECTION			-	+			L	L			3	3			3	3			3	1
MAKE SPAR SPLICE			-	+			L	L			5	3			3	3			3	3
USE NACA AIRFOIL SPECIFICATIONS			-	+			L	L			3	3			3	3			3	1
CONSTRUCT JIGS			-	+		H	L	L		4	5	3		3	3	3		1	3	3
SELECT MATERIALS			-	+	H		L	L	3		3	3	3		3	3	1		3	3
HANDLE AND STORE WOOD			-	+	H		L	L	1		1	3	2		3	3	1		3	3
TEST STRENGTH OF SPLICES			-	+			L	L			1	3			3	3			3	3
MAKE APPROVED SPLICES			-	+	H		L	L	3		3	3	4		3	3	1		3	3

TABLE 1

WOODWORK

OVERVIEW OF WORK PERFORMED

While the trend is undoubtedly toward metal aircraft, many airplanes still exist in which wood was used as the structural material for spars and ribs. Inspection and repair of these wooden structures will continue to be the responsibility of the aviation mechanic, because deterioration is continuous and cracks in glued joints are in many cases difficult to detect. The mechanic must be familiar with and able to recognize defects in wood structures such as dry rot, compression failures, etc.

The manufacture of duplicate replacement parts and the application of protective finishes is performed by the mechanic, and woodworking machines are used during these processes.

PRINCIPAL FINDINGS

N - Very few mechanics employed by the airlines and large general aviation companies do any woodworking. Where such jobs exist in general aviation, they are being done by a small percentage of mechanics, most of whom specialize in this type of work.

F - The frequency with which mechanics employed by general aviation companies perform such work is low.

I - Basic or general information training is provided by the general aviation industry.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

A mechanic should have the ability to inspect wood structures and make correct decisions regarding airworthiness of the structures. Although all subtopics except the identification of wood defects are to be taught at Teaching Level 1, which precludes manipulative training, the committee strongly recommended that the mechanic be familiar with the use of woodworking tools. All subtopics should be included in the core curriculum at Teaching Level 1, except the identification of wood defects, which should be taught at Teaching Level 2.

TABLE 2. FABRIC COVERING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INSPECT AND REPAIR STRUCTURE FOR COVER			+	+	L	H	L	H	2	3	3	3	2	3	3	3	2	4	3	3
SELECT MATERIALS			+	+	L		L	H	3		3	3	3		3	3	1		3	3
PERFORM HAND SEWING			+	+	H	H	L	H	3	3	3	3	3	3	3	3	1	4	3	3
COVER WING, STRUCTURE, OR CONTROL SURFACE			+	+	H		L	H	3		3	3	3		3	3	3		3	3
REPAIR FABRIC			+	+	L	H	H	H	3	3	3	3	3	3	3	3	2	4	3	3
PERFORM FABRIC PROTECTION AND TESTING			+	+	L	H	H	H	3	3	3	3	3	3	2	3	1	4	3	3
PERFORM POWER SEWING			$	+	H	H	L	L	2	2	3	3	3	3	3	3	2	1	3	3

TABLE 2

FABRIC COVERING

OVERVIEW OF WORK PERFORMED

In the past, and at present, on slower, lighter aircraft, fabric has been used to cover a portion of the airplane structure. Mechanics select and identify materials, make repairs, and test fabric to determine the airworthiness of the fabric cover. Fabric covering of a wing, structure, or control surface requires the ability to cut fabric to proper size and to sew and to properly attach the fabric to the aircraft.

PRINCIPAL FINDINGS

N - Less than 2 percent of the airline mechanics work with fabric covering. They find their work generally limited to the inspection, testing, and repair of fabric covered control surfaces.

F - Major aircraft-covering jobs and power sewing are performed at a low frequency by mechanics employed by large general aviation companies.

I - The airline overhaul mechanic is given in-depth training when his employer assigns him the tasks identified in this table.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The subtopic "Perform power sewing" should be deleted from the curriculum. The committee observed that power sewing is generally done by mechanics in a specialized shop and should not be a part of a mechanic's basic skill. The subtopic "Inspect and repair structure for cover" was also deleted from this area, "Fabric covering," inasmuch as it is more applicable to "Woodwork" and "Sheet Metal." All other subtopics should be included in the aviation mechanics core curriculum.

TABLE 3. PAINTING AND FINISHING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
PREPARE SURFACE AND PRIME	$	–	+	+	H	H	H	H	2	3	3	3	3	3	3	3	2	4	3	3
BRUSH PAINTING	$	–	+	+	H	H	H	H	2	3	3	3	3	3	2	3	2	3	3	3
SPRAY PAINTING	$	–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	2	4	3	3
LAYOUT LETTERS AND MASK	$	–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	2	4	3	3
LAYOUT TRIM DESIGN	$	–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3
INSPECT AND IDENTIFY DEFECTS	$	–	+	+	H	H	H	H	3	3	3	3	3	3	3	2	2	4	3	3
TOUCH-UP PAINTING	$	–	+	+	H	H	H	H	3	3	3	3	3	3	2	3	2	1	3	3
APPLY DOPE			+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3

TABLE 3

PAINTING AND FINISHING

OVERVIEW OF WORK PERFORMED

Metal- or wood-covered aircraft are usually painted to protect their surfaces and to provide a desirable appearance. Fabric covering requires the mechanic to brush or spray multiple coats of clear or pigmented dope on the surfaces to preserve and tighten the fabric. Wood structures are varnished, while aluminum and steel are protected and preserved by painting with zinc chromate or other similar finishes. The application of aircraft identification numbers and letters and trim striping requires the mechanic to be familiar with available materials and methods employed for their application.

PRINCIPAL FINDINGS

F - Mechanics in all occupational categories perform painting and finishing at a high frequency. Few airline mechanics apply dope, yet the frequency for painting and finishing is high.

I - Airline overhaul stations offer extensive training in the majority of the painting and finishing subtopics.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee observed that the time and effort required to lay out trim design and letters, mask, and do touch-up painting can only be justified at the knowledge level of teaching. The committee further recommended that all training programs remain alert to the introduction of new materials and processes in this subject area.

TABLE 4. SHEET METAL

	N	F	T	M	I
	A O L S	A O L S	A O L S	A O L S	A O L S
INSTALL CONVENTIONAL RIVETS	+ + + +	H H H H	3 3 3 3	3 3 3 3	3 3 3 3
DIMPLE METAL	+ + + +	H H H H	3 3 3 3	5 3 3 3	3 3 3 3
INSTALL SPECIAL RIVETS	+ + + +	H H H H	3 3 3 3	5 3 3 3	4 3 3 3
INSTALL SPECIAL FASTENERS	+ + + +	H H H H	3 3 3 3	3 3 3 3	3 3 3 3
MAKE PATCHES	+ + + +	H H H H	3 3 3 3	3 3 3 3	3 3 3 3
MAINTAIN AERODYNAMIC SMOOTHNESS	+ + + +	H H H H	3 3 3 3	3 3 3 3	3 3 3 3
FABRICATE FROM TEMPLATE	$ + + +	L H H L	3 2 3 3	5 3 3 3	4 3 3 1
HAND FORMING	$ + + +	H H H H	3 2 3 3	3 3 3 3	3 3 3 3
PROTECT METAL FROM DAMAGE	$ + + +	H H H H	3 3 3 3	3 3 2 3	3 3 2 3
USE BEND ALLOWANCE	$ + + +	H H H H	3 3 3 3	3 3 3 3	3 4 3 3
IDENTIFY AND CONTROL CORROSION	$ + + +	H H H H	3 1 3 3	3 3 3 3	3 3 3 3
REPAIR STRUCTURE	- + + +	H H H H	3 3 5 3	5 3 3 3	4 3 3 3
USE ADHESIVE METAL BONDING	- + + +	H H H H	3 3 3 3	4 3 3 3	4 4 3 3
DEVELOP TEMPLATE FROM BLUEPRINT	$ $ + +	L H H L	3 3 3 3	5 3 3 3	4 4 3 1
INSPECT AND REPAIR PLASTICS AND FIBERGLASS	- - + +	H H H H	3 3 3 3	3 3 3 3	4 4 3 3
SHAPE METAL I.E. HOT WORKING, COLD WORKING, CASTING, CHEMICAL MILLING, ETC.	- + +	H H H L	3 2 3 3	3 3 3 3	4 3 3 1
REPAIR HONEYCOMB AND LAMINATED STRUCTURE	- - $ +	H H L L	3 3 3 3	5 3 3 3	4 4 3 3

TABLE 4

SHEET METAL

OVERVIEW OF WORK PERFORMED

Structural members of the modern airplane are made of aluminum alloys, steel, and other non-ferrous metals and honeycomb structures. The outer covering, or "skin," of the airplane is generally made of aluminum alloy or other non-ferrous sheet metals. Aviation mechanics manufacture, assemble, repair, and fasten parts together by riveting, welding, and bonding. Special fasteners and fittings are installed as a part of this process. Mechanics inspect the structure for damage or normal wear and control corrosion by application of primers, chemical bonds, and plating.

PRINCIPAL FINDINGS

N - All mechanics perform the tasks identified in this table. The shaping of metal by hot or cold working, casting, chemical milling, etc., is performed by less than 2 percent of the mechanics employed at airline line stations.

F - Airline line mechanics and mechanics employed by small general aviation companies infrequently develop templates or fabricate parts from templates. The repair of honeycomb and laminated structure is performed infrequently by general aviation companies.

M - Airline line station mechanics do sheet metal work under critical time limitations that require job planning.

I - The airline industry provides training in depth in several of the tasks.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee recommended that manipulative skill should not be taught for the subtopics "Protect metal from damage" and "Identify and control corrosion." The theory and techniques of shaping metal, i. e. hot working, cold working, casting, chemical milling, etc., should be presented in sufficient detail so the mechanic can properly conduct an inspection.

TABLE 5. WELDING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
SOLDER	$	$	+	+	H	H	H	H	3	3	3	3	2	3	3	3	4	3	3	3
IDENTIFY TYPES OF WELDED JOINTS		-	+	+	H	H	H	H	1	2	3	3	2	3	3	3	1	3	3	3
WELD STAINLESS STEEL		-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	4	3	1	1
ARC WELDING		-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	4	3	1	1
SOLDER STAINLESS STEEL		-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	1
FABRICATE TUBULAR STRUCTURES		-	+	+	H	H	H	L	3	3	3	3	3	3	3	3	3	3	1	1
CONTROL ALIGNMENT WHILE WELDING		-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	2	1
INSPECT AND TEST WELDS		-	+	+	H	H	H	H	4	3	5	3	5	3	1	3	4	3	3	3
WELD STEEL (GAS)			+	+	H	H	H	H	3	3	3	3	3	3	3	3	4	3	3	1
WELD ALUMINUM			+	+	H	H	H	H	3	3	3	3	3	3	3	3	4	3	1	1
BRAZE			+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3
REPAIR TANK		-	$	+	H	H	H	L	3	3	3	3	3	3	3	3	1	3	3	1
WELD MAGNESIUM				-	H	H	L	L	3	3	3	3	3	3	3	5	4	3	3	1
WELD TITANIUM				-	H	H	H	H	3	3	3	3	3	3	3	5	4	3	1	1

TABLE 5

WELDING

OVERVIEW OF WORK PERFORMED

Recent developments and refinements in inert gas welding have brought significant changes in the methods of joining metals in aircraft. Conventional gas and arc welding are done by the mechanic in repairing tubular aircraft components, minor subassemblies and shop equipment. Some mechanics who have special training, or certification, weld stainless steel and magnesium, as well as titanium and other exotic metals. It is most important that mechanics be able to identify the quality of the weld.

PRINCIPAL FINDINGS

N - A smaller percent of mechanics employed by the airlines do welding, compared with mechanics employed in general aviation.

F - Although only a few selected airline mechanics do welding, they perform this task at a high frequency. The frequency with which mechanics employed by small general aviation companies fabricate tubular structures, repair tanks, and weld magnesium is low.

I - Less than 2 percent of the airline line mechanics do welding, but they indicate that they receive in-depth training in the majority of the tasks identified.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. For purposes of inspection, a mechanic must be able to identify the various types of welded joints and be capable of judging the quality of the weld. Welding in the core curriculum should be at the application level; however, those students specializing in aircraft welding for certification must enroll in special classes.

TABLE 6. ASSEMBLY AND RIGGING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
USE MANUFACTURER'S AND FAA SPECIFICATIONS	$	$	+	+	H	H	H	H	2	3	3	3	4	1	3	3	3	3	3	3
RIG MOVEABLE SURFACES	$	–	+	+	H	H	H	H	3	3	5	3	3	3	5	3	4	4	3	3
RIG FIXED SURFACES		–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	4	4	3	3
RIG AIRCRAFT		–	+	+	H	H	H	L	3	3	3	3	3	3	3	3	4	4	3	3
USE TRANSIT			+	+	L	H	L	L	3	3	3	3	3	3	3	3	1	3	1	1
TRAM AND ALIGN STRUCTURE			+	+	L	H	H	L	3	3	3	3	3	3	3	3	3	3	3	3
BALANCE CONTROL SURFACES			+	+	L	H	L	L	3	3	3	3	3	3	3	3	3	3	3	3

TABLE 6

ASSEMBLY AND RIGGING

OVERVIEW OF WORK PERFORMED

Every airplane has its particular method of assembly. The number of externally braced aircraft is decreasing. Designs that incorporate external braces and wires permit many adjustments; modern internally braced airplanes permit few adjustments by mechanics in the field. Aircraft rigging implies the alignment of components to achieve acceptable flight characteristics. Furthermore, improper assembly and rigging may result in certain members being subjected to loads greater than those for which they were designed. Mechanics, therefore, closely adhere to the manufacturer's and FAA specifications when installing, aligning, or balancing both fixed and movable control surfaces. Aircraft with hydraulic or electric boost-assisted controls demand a high level of mechanical craftsmanship.

PRINCIPAL FINDINGS

N - A greater percentage of the mechanics employed by general aviation companies perform assembly and rigging operations than do the mechanics employed by the airlines.

F - Mechanics in all of the industrial categories make frequent use of manufacturer's and FAA specifications.

T - Mechanics employed by large general aviation companies must frequently put together knowledge of principles and procedures when rigging movable surfaces.

M - Mechanics employed by large general aviation often work under critical time conditions requiring job planning when rigging movable surfaces.

I - The airlines give training in depth for the rigging of aircraft, movable surfaces, and fixed surfaces.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee suggested that the correct installation and assembly of bolts and similar items of special hardware is of sufficient importance to justify addition of a separate subtopic titled "Assembly of aircraft" to the curriculum. In the core curriculum on page 179 a new subtopic "Assembly of Aircraft" has been included to be taught at Teaching Level 3.

TABLE 7. LANDING GEAR

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
SERVICE AND REPAIR																				
LANDING GEAR	+	–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3
INSPECT AND REPLACE TIRES AND WHEELS	+	–	+	+	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	3
SERVICE AND REPAIR																				
LEVELING DEVICES	+	–	+	+	H	H	H	H	3	3	3	3	4	3	3	3	3	4	3	3
SHOCK STRUTS	+	–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3
NOSE WHEEL STEERING	+	–	+	+	H	H	H	H	3	4	3	3	3	5	3	3	3	4	3	3
BRAKES	+	–	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3
JACK AIRCRAFT AND TEST GEAR	$	–	+	+	H	H	L	H	3	4	4	3	3	5	1	3	3	4	3	3
INSPECT DAMAGE AND WEAR TO LIMITS	$	–	+	+	H	H	H	H	3	4	3	3	2	3	3	3	3	4	3	3
CHECK ALIGNMENT	–	–	+	+	L	H	H	H	1	4	3	3	3	3	3	3	1	4	3	3
SERVICE AND REPAIR																				
ANTI–SKID DEVICES	–	–	+	+	H	H	H	L	4	4	3	3	3	3	3	3	3	4	3	3

TABLE 7

LANDING GEAR

OVERVIEW OF WORK PERFORMED

The landing gear of an airplane consists of main and auxiliary units, either of which may be retractable or fixed. The landing gear may include various combinations of wheels, shock absorbing equipment, brakes, retracting mechanism with controls, actuators, warning devices, fairings, and structural members necessary to attach it to the primary structure. Mechanics operate, service, adjust, inspect, repair, and maintain these many systems.

PRINCIPAL FINDINGS

F - Mechanics in all occupational categories work on landing gear at a high frequency.

T - Airline overhaul mechanics perform several tasks at the analysis level, requiring an ability to break down a malfunction into its fundamental parts--to perform troubleshooting during overhaul.

M - In three of the subtopic tasks, airline mechanics must perform their work under the pressure of time limitations.

I - Airline overhaul stations provide training in depth, while industry training is basic and informational in content.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee observed that, with the possible exception of powerplants, the landing gear requires the most frequent inspection, maintenance, and service.

TABLE 8. HYDRAULIC AND PNEUMATIC SYSTEMS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
OPERATE AND SERVICE HYDRAULIC SYSTEM AND COMPONENTS	+	$	+	+	H	H	H	H	3	3	4	3	3	1	4	3	3	3	3	3
OPERATE AND SERVICE PNEUMATIC SYSTEM AND COMPONENTS	+	$	+	+	H	H	H	H	3	4	4	3	3	5	4	3	3	4	1	3
IDENTIFY VARIOUS TYPES OF HYDRAULIC SYSTEMS	+	-	+	+	H	H	H	H	3	3	4	3	3	1	2	3	3	3	3	3
IDENTIFY VARIOUS TYPES OF PNEUMATIC SYSTEMS	+	-	+	+	H	H	L	L	3	3	4	3	3	1	1	3	3	3	4	3
IDENTIFY HYDRAULIC FLUIDS	+	-	+	+	H	H	H	H	3	3	4	3	2	1	5	3	3	3	3	3
INSTALL FITTINGS AND LINES	+	-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3
INSPECT AND REPAIR HYDRAULIC SYSTEM AND COMPONENTS	$	$	+	+	H	H	H	H	3	3	3	3	5	1	3	3	3	3	3	3
INSPECT AND REPAIR PNEUMATIC SYSTEM AND COMPONENTS	$	$	+	+	H	H	H	H	3	3	4	3	5	5	3	3	3	3	3	3
FABRICATE ALUMINUM LINES	-		+	+	H	H	H	H	3	3	4	3	2	3	3	3	3	3	3	3
FABRICATE STAINLESS LINES	-		+	+	H	H	H	H	3	3	3	3	2	3	3	3	3	3	3	3

TABLE 8

HYDRAULIC AND PNEUMATIC SYSTEMS

OVERVIEW OF WORK PERFORMED

The size, weight, and speed of the modern airplane has made necessary the development of more sophisticated and complex hydraulic and pneumatic systems. The aviation mechanic operates, services, inspects, repairs, and maintains these systems. This responsibility varies from simple identification of hydraulic fluids and seals to the ability to analyze and troubleshoot reported system malfunctions.

PRINCIPAL FINDINGS

F - Mechanics in all industrial categories perform work at a high rate of frequency on hydraulic systems.

T - Large general aviation companies require their mechanics to work at the analysis level, troubleshooting hydraulic and pneumatic systems.

M - Mechanics employed by the airlines and large general aviation companies must perform several of the tasks under critical time conditions, requiring job planning.

I - Airline overhaul mechanics receive in-depth training in the operation and servicing of pneumatic systems and components.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee recommended the addition of a subtopic titled "Selection, and installation of 'O' rings and seals" to emphasize a task often performed by the mechanic. He should also be aware of the function of "O" rings and seals. The term "repair" as applied to components in the hydraulic and pneumatic systems was further defined by the committee to describe a "remove and replace" function. In the core curriculum on page 180 under "Hydraulic and Pneumatic Systems," a subtopic titled "Selection and installation of 'O' rings and seals" has been added.

TABLE 9. FUEL SYSTEM

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY FUEL SYSTEMS	+	−	+	+	H	H	H	H	2	3	3	3	2	3	1	3	3	3	2	3
CHECK AND SERVICE FUEL SYSTEMS AND COMPONENTS	+	−	+	+	H	H	H	H	3	3	3	3	3	3	2	3	3	3	3	3
IDENTIFY FUELS	+		+	+	H	H	H	H	2	3	1	3	2	3	1	2	3	3	3	1
SERVICE FUEL DUMP SYSTEMS	+		+	+	H	H	L	L	3	3	5	3	2	3	1	2	3	4	1	3
FABRICATE AND REPLACE LINES AND FITTINGS	$	−	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3
INSPECT AND REPAIR FUEL SYSTEM COMPONENTS	$		+	+	H	H	H	H	4	3	3	3	4	2	3	3	4	3	3	3
REPAIR AND SEAL FUEL TANKS	−		+	+	H	H	H	L	1	3	3	3	5	3	3	3	3	4	3	3

TABLE 9

FUEL SYSTEMS

OVERVIEW OF WORK PERFORMED

The aviation mechanic services, checks, and maintains the fuel system and components. The work includes fabricating lines, inspection for fuel leaks, replacing fittings, and repairing or replacing fuel tanks and bladder cells. The inspection for fuel leaks and contamination is one of the major safety items a mechanic performs during his continual flight line checks.

PRINCIPAL FINDINGS

N - Less than 5 percent of the airline overhaul mechanics perform the tasks identified in this table.

F - General aviation mechanics do not service fuel dump systems as frequently as do airline mechanics. Mechanics employed by small general aviation companies infrequently repair and seal fuel tanks.

T - Airline line mechanics must be capable of analyzing the problem and making corrections when inspecting and repairing fuel system components.

M - Airline line mechanics inspect and repair fuel system components and repair and seal fuel tanks under critical time conditions.

I - Airline mechanics are trained in depth to service fuel dump systems, to inspect and repair fuel system components, and to repair and seal fuel tanks.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. Training in checking, servicing, inspecting, and repairing fuel systems and components should be general and not be specifically directed to a particular airplane or system.

TABLE 10. AIR CONDITIONING AND PRESSURIZATION

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND SERVICE PNEUMATICS AND HEAT EXCHANGERS	+	-	+	+	H	H	H	H	3	3	3	3	3	2	3	3	3	3	3	3
INSPECT, REPLACE OR REPAIR																				
PNEUMATIC SYSTEM COMPONENTS	+	-	+	+	H	H	H	H	3	3	3	3	3	2	5	3	3	3	3	3
AIR CONDITIONING SYSTEM COMPONENTS	+	-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3
CHECK AND SERVICE HEAT AND COOLING SYSTEMS AND THEIR CONTROL SYSTEMS	+		+	+	H	H	H	H	3	4	3	3	3	3	3	3	3	4	3	3
CHECK AND SERVICE OXYGEN SYSTEMS	+		+	+	H	H	L	H	3	4	5	3	3	3	5	3	3	4	3	3
CHECK AND SERVICE AIRCRAFT PRESSURIZATION AND CONTROL SYSTEMS	+	-	+	$	H	H	H	H	3	3	5	3	3	3	3	3	3	4	1	1
INSPECT, REPLACE OR REPAIR																				
PRESSURIZATION SYSTEM COMPONENTS	+	-	+	$	H	H	L	H	3	3	5	3	3	2	5	3	3	3	3	1
OXYGEN SYSTEMS AND COMPONENTS	$		+	+	H	H	L	H	3	3	3	3	3	3	3	3	3	4	3	3
TROUBLESHOOT AND REPAIR AIR CONDITIONING AND PRESSURIZATION SYSTEMS	$		+	$	H	H	L	H	4	4	4	4	5	3	3	3	4	4	3	1

TABLE 10

AIR CONDITIONING AND PRESSURIZATION

OVERVIEW OF WORK PERFORMED

Air conditioning and pressurization systems are incorporated in aircraft primarily for passenger comfort while the aircraft operates at higher or more efficient altitudes. On some of the more complex aircraft, a secondary benefit derived from air conditioning is the stable, temperature-controlled environment it provides for the most efficient operation of other aircraft subsystems.

Most airline aircraft utilize complex air conditioning and pressurization systems. Aircraft are being introduced into general aviation which also incorporate these subsystems. Oxygen systems are related to air conditioning and pressurization systems; therefore, the mechanic must also be familiar with oxygen systems. These require continual, periodic checking, servicing, and troubleshooting. The mechanic must be familiar with these phases of the systems to inspect, repair, and replace system components to effect proper maintenance.

PRINCIPAL FINDINGS

N - Less than 5 percent of the airline overhaul mechanics perform the tasks identified in this table.

F - Generally, mechanics in all four categories perform work on air conditioning and pressurization systems at a high frequency.

T - The technical knowledge required of mechanics who repair air conditioning and pressurization systems is at the analysis level.

M - Airline line stations require their mechanics to work under pressure of time and do job planning to troubleshoot and repair air conditioning and pressurization systems.

I - Airline overhaul stations provide in-depth training for most of the tasks.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. No manipulative skill training should be required under the subtopics titled "Inspect, replace, or repair: Pneumatic system components," "Inspect, replace, or repair: Pressurization system components," "Inspect, replace, or repair: Oxygen systems and components." The committee believes that few mechanics are expected to work on air conditioning or pressurization systems without additional special training.

TABLE 11. ELECTRICAL POWER

	N A O L S	F A O L S	T A O L S	M A O L S	I A O L S
APPLY ELECTRON THEORY AND FUNDAMENTALS OF ELECTROMAGNETISM					
IN READING AND ANALYZING DC AND AC CIRCUITS AND DIAGRAMS	+ - + +	H H H H	4 3 5 3	3 3 3 3	3 4 3 3
IN OPERATION AND TESTING OF DC AND AC ELECTRICAL COMPONENTS	+ - + +	H H H H	4 3 5 3	3 3 3 3	2 4 3 3
APPLY ELECTRICAL MEASURING AND INDICATING DEVICES FOR					
MEASUREMENT OF VOLTAGE, CURRENT, AND RESISTANCE	+ - + +	H H H H	3 3 2 3	3 2 3 2	3 3 3 3
CHECKING OF CONTINUITY AND ELECTRICAL LEAKAGE	+ - + +	H H H H	3 3 3 3	3 1 2 3	3 3 3 3
PROMOTE AND PRACTICE ELECTRICAL SAFETY AND HAZARD PRECAUTIONS	+ - + +	H H H H	3 1 3 3	3 1 2 3	4 3 3 3
APPLY ELECTRON THEORY AND FUNDAMENTALS OF ELECTROMAGNETISM					
IN TROUBLE SHOOTING AIRCRAFT WIRING AND ELECTRICAL INSTALLATIONS	$ - + +	H H H H	3 3 5 3	3 3 3 3	3 4 3 3
APPLY ELECTRICAL MEASURING AND INDICATING DEVICES FOR					
CALCULATION OF RESISTANCE AND CONDUCTIVITY	$ - + +	H H H H	3 3 5 3	2 1 3 3	4 3 2 3
CHECKING AND MEASURING CAPACITANCE	$ - + +	H H H H	3 3 5 3	3 2 3 2	3 3 2 3
CHECKING AND MEASURING INDUCTANCE	$ - + +	H H H H	3 3 3 3	3 2 3 3	3 3 3 3
TROUBLE SHOOT AND REPLACE DC AND AC MOTORS AND CONTROL UNITS	$ - + +	H H H H	3 2 4 3	3 3 3 3	3 3 3 3
CHECK AND REPLACE RELAYS, SOLENOIDS, SWITCHES AND RHEOSTATS	$ - + +	H H H H	3 2 5 3	3 2 3 3	3 3 3 3

TABLE 11

ELECTRICAL POWER

OVERVIEW OF WORK PERFORMED

Mechanics apply electrical theory in checking, servicing, and troubleshooting aircraft electrical systems. Electrical system maintenance requires a broad knowledge of the fundamentals of electricity. The effective use of measuring instruments is paramount in electrical servicing. Power generating and distribution systems contain many components, such as switches, circuit breakers, bus bars, relays, generators, inverters, regulators, etc., which require inspection, testing, and replacement where necessary. Recent developments in the electrical systems of modern aircraft have placed greater emphasis on the mechanic's ability to troubleshoot, service, and maintain the systems.

PRINCIPAL FINDINGS

F - With but one exception, checking and troubleshooting solid state switching devices by mechanics in small general aviation companies, all subtopics have a high frequency of performance by mechanics performing these tasks in all four industrial categories.

T - Many of the tasks require a technical knowledge at the analysis level by all four industrial categories. Large general aviation companies indicate that they require a technical knowledge at the synthesis level for many of the tasks. It is evident that a broad knowledge of aircraft electrical/electronic systems and subsystems is an important part of the aviation mechanic's working requirements.

M - Mechanics employed by large general aviation companies indicate that they work under time critical conditions, which require job planning, in applying electrical measuring and indicating devices for measurement and calculation of power and installing and repairing electrical wiring and distribution equipment. Airline overhaul mechanics also indicate that they require a high manipulative skill level to test and repair solid state inverters and switching devices under time critical conditions requiring job planning.

I - Although airline mechanics indicate that they receive in-depth training in some of the subtopics, industry training is generally of basic, informational content.

TABLE 11. ELECTRICAL POWER (CONTINUED)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND REPLACE TRANSFORMERS, RECTIFIERS AND FILTERS	$	-	+	+	H	H	H	H	3	2	5	3	3	2	3	3	3	3	3	1
CHECK AND REPLACE ELECTRICAL PROTECTIVE DEVICES	$	-	+	+	H	H	H	H	3	2	5	3	3	2	3	3	3	3	3	3
APPLY ELECTRON THEORY AND FUNDAMENTALS OF ELECTROMAGNETISM																				
IN TROUBLE SHOOTING AIRCRAFT AC POWER SYSTEMS	-	-	+	+	H	H	H	H	4	4	4	4	3	4	3	3	4	4	3	3
IN TROUBLE SHOOTING AIRCRAFT DC POWER SYSTEMS	-	-	+	+	H	H	H	H	4	4	5	4	3	4	3	3	4	4	3	3
APPLY ELECTRICAL MEASURING AND INDICATING DEVICES FOR																				
MEASUREMENT AND CALCULATION OF POWER	-	-	+	+	H	H	H	H	3	3	5	3	3	2	5	2	3	3	3	1
CHECKING AND TESTING THERMOCOUPLES	-	-	+	+	H	H	H	H	3	3	3	3	2	3	3	3	4	3	3	3
TROUBLE SHOOT AND REPLACE DC AND AC GENERATOR EQUIPMENT	-	-	+	+	H	H	H	H	4	2	4	3	3	3	3	3	3	3	3	3
INSTALL AND REPAIR ELECTRICAL WIRING AND DISTRIBUTION EQUIPMENT	-	-	+	+	H	H	H	H	2	2	5	3	3	3	5	3	3	3	3	3
TEST AND REPAIR AIRCRAFT GENERATOR AND INVERTER CONTROL SYSTEMS	-	-	+	+	H	H	H	H	3	4	5	3	3	2	3	3	3	4	3	3
APPLY BATTERY THEORY AND TEST EQUIPMENT																				
TO MAINTAIN AND TEST LEAD ACID BATTERIES	-		+	+	H	H	H	H	3	3	3	3	1	2	2	2	3	4	3	3
TO TEST AND MAINTAIN EDISON CELLS AND NICKEL CADMIUM BATTERIES	-		+	+	H	H	H	H	3	3	3	3	2	2	2	3	3	3	3	3
TO OPERATE AND MAINTAIN BATTERY CHARGERS	-		+	+	H	H	H	H	3	3	3	3	2	2	2	2	3	3	3	3

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended that the subtopic, "Apply battery theory and test equipment to test and service dry battery equipment" be deleted because of extremely limited use of this equipment. All other subtopics should be included in the aviation mechanics core curriculum. It is fairly evident that a knowledge of aircraft electrical systems is becoming an important aspect of the aviation mechanic's working requirements. Although the committee was aware that the electrical and electronic work is performed by specialists in some of the aviation industries, electrical and electronics should be a part of the aviation mechanics curriculum at the application level. Committee comments and recommendations also included the following:

1) Solid state switching devices are becoming more important and finding more use in light aircraft.

2) Although AC devices are finding more use in aircraft, DC theory and devices should also be emphasized during instruction.

3) "Check and replace" tasks should all be taught at no less than Level 3.

4) The high percentage of mechanics performing the tasks in all four categories indicates the need for electrical training.

5) The student/mechanic needs a broad foundation of instruction for the installation of aircraft electrical units and wiring.

6) Industry training may be high for the subtopics because no other adequate training is received.

TABLE 11. ELECTRICAL POWER (CONTINUED--2)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND TROUBLE SHOOT SOLID STATE INVERTERS	-		+	+	H	H	H	H	3	4	4	3	3	4	3	3	3	4	3	3
INSPECT, TEST AND REPAIR AIRCRAFT MOTORS, GENERATORS AND INVERTERS	-		+	+	H	H	H	H	3	4	5	3	3	2	1	3	3	4	3	3
APPLY BATTERY THEORY AND TEST EQUIPMENT																				
TO TEST AND SERVICE DRY BATTERY EQUIPMENT			+	+	H	H	H	H	3	3	5	3	3	2	3	2	3	3	2	3
CHECK AND TROUBLE SHOOT SOLID STATE SWITCHING DEVICES	-		$	+	H	H	H	L	4	4	4	3	3	2	3	3	3	4	3	3
TEST AND REPAIR SOLID STATE INVERTERS AND SWITCHING DEVICES	-		$	+	H	H	H	H	3	4	4	3	3	5	3	3	2	4	3	3

TABLE 12. FLIGHT INSTRUMENTS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
TROUBLE SHOOT AND MAINTAIN																				
MAGNETIC COMPASSES AND HEADING INDICATORS	-	-	+	+	H	H	L	H	3	3	5	3	3	2	3	3	4	4	1	3
AIRSPEED INDICATORS AND MACHMETERS	-	-	+	+	H	H	H	H	3	3	5	3	3	2	1	3	4	4	3	3
ALTIMETERS, RATE-OF-CLIMB AND VERTICAL SPEED INDICATORS	-	-	+	+	H	H	L	H	3	3	1	3	3	2	3	3	4	4	3	3
CLOCKS AND ELAPSED TIME INDICATORS	-	-	+	+	H	H	L	H	3	3	4	3	2	2	3	3	4	3	3	3
TEMPERATURE AND PRESSURE INSTRUMENTS	-	-	+	+	H	H	H	H	3	3	5	3	2	3	3	3	3	4	3	3
TURN AND BANK, HORIZON, AND YAW INSTRUMENTS	-	-	+	+	H	H	H	H	3	2	3	3	3	3	3	3	3	4	3	3
FLAP AND CONTROL SURFACE POSITION INDICATORS	-	-	+	+	H	H	H	H	3	3	3	3	3	2	3	3	3	4	3	3
TROUBLE SHOOT AND MAINTAIN																				
PITOT STATIC, RAM AIR AND VACUUM SYSTEMS	-	-	+	+	H	H	H	H	3	2	3	3	3	3	3	3	4	4	3	3
RESISTANCE AND THERMOCOUPLE INDICATOR SYSTEMS	-	-	+	+	H	H	H	H	3	3	3	3	3	2	3	3	4	4	3	3
SYNCHRO REMOTE INDICATION SYSTEMS	-	-	+	+	H	H	H	H	3	4	5	3	3	3	2	3	4	4	3	3
TEST AND REPAIR																				
COMPASSES AND HEADING INDICATOR SYSTEMS	-	-	+	+	H	H	H	L	3	4	1	3	3	5	3	3	4	4	4	3
AIRSPEED, RATE-OF-CLIMB AND ALTITUDE INDICATOR SYSTEMS	-	-	+	+	L	H	H	H	3	3	3	3	3	3	3	3	4	4	3	3
TEMPERATURE AND PRESSURE INDICATION SYSTEMS	-	-	+	+	H	H	H	L	3	3	5	3	2	3	4	3	4	3	3	3

TABLE 12

FLIGHT INSTRUMENTS

OVERVIEW OF WORK PERFORMED

Safe, reliable operation of the modern airplane is dependent upon the use of flight instruments. The mechanic is not only responsible for proper inspection and maintenance of the instrument systems, but he must also learn to use them for intelligent diagnosis of troubles. Mechanics service and maintain instrument systems, verify the accuracy of individual instrument indications, and replace instruments as required.

PRINCIPAL FINDINGS

N - Less than 5 percent of the airline mechanics perform the tasks identified in this table.

F - The frequency at which mechanics work with flight instruments is generally high.

I - Mechanics employed in general aviation do not receive industry training in the more complex instrument systems, while the airlines provide training in depth.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum, but the training should be adjusted to develop comprehension without a requirement for manipulative skill in the subtopic titled "Test and repair: Compasses and heading indicator systems," "Test and repair: Airspeed, rate-of-climb, and altitude indicator systems." There are indications that there will continue to be developments and refinements in instrument systems that will further improve their accuracy and reliability. These developments will demand that mechanics have a broad understanding of the instrument systems even though they do not repair the internal mechanisms of the instruments. Mechanics should be familiar with these instrument systems, test procedures, and test equipment.

TABLE 12. FLIGHT INSTRUMENTS (CONTINUED)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
TROUBLE SHOOT AND MAINTAIN																				
ELECTRONIC INDICATING AND COMPUTING SYSTEMS	-	-	$	+	H	H	H	H	3	4	4	3	3	3	3	3	4	4	3	1
INTEGRATED TYPE OF FLIGHT INSTRUMENTATION	-	-	+	$	H	H	L	L	3	3	5	3	3	5	5	3	4	4	3	1
TEST AND REPAIR																				
ELECTRONIC COMPUTERS AND INTEGRATING SYSTEMS	-	-	+	-	H	H	H	H	3	5	5	3	3	5	3	3	4	4	3	1
SYNCHRO SYSTEMS AND MAGNETIC AMPLIFIERS	-	-	$	-	H	H	H	H	3	4	3	3	2	3	3	3	4	4	3	1

TABLE 13. AUTO PILOTS AND APPROACH CONTROLS

	N	F	T	M	I
	A O L S	A O L S	A O L S	A O L S	A O L S
OPERATE AND CHECK AUTO PILOT AND APPROACH CONTROL SYSTEMS	- - + +	H H H H	4 3 4 3	2 2 3 3	4 4 4 1
TROUBLE SHOOT AND MAINTAIN					
FLIGHT CONTROL SERVO UNITS	- - + +	H H H H	4 3 5 3	3 2 4 3	4 4 4 1
CHECK AND TROUBLE SHOOT AUTO PILOT INTERLOCK SYSTEMS	- - + $	H H H H	4 3 5 3	2 2 2 3	4 4 3 1
TROUBLE SHOOT AND REPLACE AUTO PILOT AND APPROACH CONTROL COMPUTERS AND AMPLIFIER UNITS	- - $ +	H H H H	4 3 4 3	2 2 3 3	4 4 4 3
TROUBLE SHOOT AND MAINTAIN					
AUTO PILOT SIGNAL SOURCE UNITS	- - + $	H H L H	4 3 5 4	3 2 3 3	4 4 4 1
POWER SUPPLIES AND PHASE CONTROL	- - + $	H H L H	4 3 3 4	3 2 5 3	4 4 4 1
INSPECT, TEST AND REPAIR					
AUTO PILOT CONTROL AND INTERLOCK SYSTEMS	- - + $	H H H H	4 3 5 3	3 2 5 3	4 4 4 3
TROUBLE SHOOT AND MAINTAIN					
HORIZONTAL STABILIZER CONTROL AND MACH TRIM SYSTEMS	- - + -	H H L H	4 3 5 4	3 2 1 3	4 4 3 3
YAW DAMPER SYSTEMS	- - + -	H H L H	4 3 5 4	3 2 3 3	4 4 4 1
AUTO APPROACH CONTROL	- - + -	H H H H	4 3 4 4	3 2 3 3	4 4 4 1

TABLE 13

AUTO PILOTS AND APPROACH CONTROLS

OVERVIEW OF WORK PERFORMED

Many modern aircraft are equipped with some type of auto pilot, and the need for servicing and maintaining these systems is becoming more evident, especially in light aircraft.

Large aircraft have extremely complex auto pilot systems integrated with boosted flight control and radio approach systems.

Mechanics maintaining these systems require specialized training.

PRINCIPAL FINDINGS

N - Less then 5 percent of all airline mechanics perform the tasks identified in this table. In general, less than 10 percent of the mechanics employed by small general aviation companies work on auto pilots and approach controls.

F - The mechanics who operate, test, inspect, troubleshoot, and maintain these systems perform at high frequency.

T - Mechanics employed by the airlines at line stations and mechanics employed by large general aviation companies must have the technical knowledge to accomplish repairs at the analysis level.

I - The airlines and large general aviation companies provide training in depth to mechanics who work with these systems.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee recommended that those subtopics where the teaching is accomplished at the comprehension level not include manipulative skill training. Specialized industry training is generally provided when mechanics are assigned these tasks.

TABLE 13. AUTO PILOTS AND APPROACH CONTROLS (CONTINUED)

	N	F	T	M	I
	A O L S	A O L S	A O L S	A O L S	A O L S
INSPECT, TEST AND REPAIR					
AUTO PILOT AND APPROACH CONTROL AMPLIFIERS, COMPUTERS AND COUPLERS	- - + -	H H H H	5 5 5 3	3 5 1 3	4 4 3 1
TROUBLE SHOOT AND MAINTAIN					
GLIDE PATH EXTENSION AND RELATED DATA COMPUTERS	- - +	H H L H	4 4 5 5	3 5 3 3	4 4 4 4
INSPECT, TEST AND REPAIR					
AUTO PILOT FLIGHT CONTROL SERVOS AND DRIVE MECHANISMS	- - $ $	H H H H	3 3 4 3	3 2 3 3	4 4 4 3
AUTO PILOT SIGNAL SOURCE SYSTEMS AND UNITS	- - $ -	H H L H	3 3 4 3	3 2 3 3	4 4 4 1

TABLE 14. AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INSPECT AND REPAIR																				
ANTENNA INSTALLATIONS	-	-	+	+	H	H	H	H	3	1	3	3	4	2	3	3	3	3	3	3
RADIO RACKS AND RELATED EQUIPMENT	-	-	+	+	H	H	H	H	3	1	3	3	4	2	3	3	3	3	3	3
RADIO AND ELECTRONIC WIRING, SWITCHING AND PROTECTIVE SYSTEMS	-	-	+	+	H	H	H	H	4	1	3	3	4	2	3	3	3	3	3	1
OPERATE AND CHECK AIRCRAFT HF AND VHF RADIO RECEIVERS AND TRANSMITTERS	-		+	+	H	H	H	H	3	2	3	3	4	3	3	3	3	3	3	1
CHECK, TROUBLE SHOOT AND REPLACE																				
VHF RECEIVER AND TRANSMITTER SYSTEMS	-		+	+	H	H	L	H	4	2	5	3	4	3	3	3	3	3	3	1
CHECK AND REPLACE																				
GYRO AND RADIO COMPASS SYSTEMS	-		+	+	H	H	H	H	3	3	3	3	4	3	3	3	3	4	4	1
ADF AND VOR SYSTEMS	-		+	+	H	H	L	H	3	3	5	3	2	3	1	3	3	4	2	1
MARKER, LOCALIZER, AND GLIDE SLOPE RECEIVERS	-		+	+	H	H	H	H	3	3	4	3	4	3	3	3	3	4	4	3
INSPECT AND REPAIR																				
CONTROL UNITS AND PANELS	-		+	+	H	H	H	H	4	3	3	3	4	3	3	3	3	3	3	1
HEADSETS, MICROPHONES, AND SPEAKERS	-		+	+	H	H	H	H	3	3	3	3	4	3	3	3	3	3	3	1
CHECK, TROUBLE SHOOT AND REPLACE																				
HF RECEIVER AND TRANSMITTER SYSTEMS	-		$	+	H	L	H	H	4	2	3	3	4	3	3	3	4	3	3	1
SERVICE AND PASSENGER COMPARTMENT INTERPHONE SYSTEMS	-		+	$	H	H	L	H	3	2	5	3	4	3	3	3	3	3	3	1

TABLE 14

AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT

OVERVIEW OF WORK PERFORMED

Mechanics are responsible for the installation of radios, antennae, navigation equipment, and associated wiring. The repair, troubleshooting, and calibration of transmitting equipment is performed by FCC licensed radio repairmen who have had additional experience with aircraft radio. Aircraft mechanics maintain the system but, when a malfunction is isolated in a unit of that system, radiomen accomplish the necessary repairs.

PRINCIPAL FINDINGS

N - Less than 5 percent of the certificated mechanics employed by the airlines work with aircraft communications and navigation equipment.

F - Most tasks identified in this table are frequently performed by mechanics in all industrial categories.

M - Mechanics employed by the airlines at line stations perform these tasks under critical time limitations.

I - Training in depth is provided by industry in some of the subtopics, while the mechanic employed by the small general aviation company generally receives no training.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended deleting the subtopic titled, "Check, troubleshoot and replace passenger announcement and entertainment systems" because this is a specialized system generally limited to airline operation. All other subtopics should be included in the aviation mechanics core curriculum.

TABLE 14. AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT (CONTINUED)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND REPLACE																				
DME AND DMET SYSTEMS AND OFF-COURSE COMPUTERS	-		+	$	H	H	H	H	3	3	5	3	2	3	3	3	3	4	4	3
WEATHER RADAR SYSTEMS	-		+	-	H	H	L	H	3	3	4	1	4	3	3	3	3	4	4	1
CHECK, TROUBLE SHOOT AND REPLACE																				
FLIGHT COMPARTMENT INTERPHONE SYSTEMS	-		$	$	H	H	L	H	3	2	4	3	4	3	3	3	3	3	3	1
CHECK AND REPLACE																				
SELCAL AND TRANSPONDER SYSTEMS	-		$	$	H	H	H	L	3	3	4	1	4	3	3	3	4	4	4	1
CHECK, TROUBLE SHOOT AND REPLACE																				
PASSENGER ANNOUNCEMENT AND ENTERTAINMENT SYSTEMS	-		$	-	H	H	H	L	3	2	3	3	4	3	3	3	3	3	3	1
CHECK AND REPLACE																				
FLIGHT DIRECTORS, DATA COMPUTERS AND INTEGRATING SYSTEMS	-		$	-	H	H	H	H	3	4	4	3	4	5	3	3	3	4	4	1
LORAN, DOPPLER RADAR, RADAR ALTIMETERS	-		-		H	H	H	H	3	4	4	5	4	3	3	3	4	4	4	4
RADIO ALTIMETERS AND TERRAIN CLEARANCE INDICATION SYSTEMS	-		-		H	H	H	L	3	4	4	3	4	4	3	3	4	4	4	3
FLIGHT RECORDERS	-				H	H	H	L	3	2	4	3	4	3	3	3	3	4	4	1

TABLE 15. ENGINE INSTRUMENTS, ELECTRICAL

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INSPECT, TEST AND REPAIR																				
ELECTRICAL CONNECTIONS AND WIRING	$	-	+	+	H	H	H	H	3	1	3	3	2	3	3	3	2	2	3	3
INSTRUMENT PANELS AND UNIT MOUNTINGS	-	-	+	+	H	H	H	H	3	1	3	3	2	3	2	3	3	2	3	3
TROUBLE SHOOT AND REPLACE																				
PRESSURE INDICATION SYSTEMS	-		+	+	H	H	H	H	3	2	3	3	2	3	3	3	3	3	3	1
TEMPERATURE INDICATION SYSTEMS	-		+	+	H	H	H	H	3	2	3	3	2	2	3	3	3	3	3	1
TACHOMETERS AND RPM INDICATORS	-		+	+	H	H	H	H	3	4	3	3	2	4	3	3	4	3	3	3
INSPECT, TEST AND REPAIR																				
ENGINE INDICATING SYSTEM COMPONENTS	-		+	+	H	H	H	H	3	4	3	3	2	4	3	3	4	3	3	1
TROUBLE SHOOT AND REPLACE																				
RATE-OF-FLOW INDICATION SYSTEMS	-		+	+	H	H	H	H	3	4	3	3	2	4	3	3	4	3	3	1

TABLE 15

ENGINE INSTRUMENTS, ELECTRICAL

OVERVIEW OF SYSTEM AND WORK PERFORMED

Engine electrical instruments serve to provide the flight crew with engine operating parameters so that they may ascertain or select engine conditions at any time. Mechanics are responsible for the installation, electrical connection, removal, servicing, and checking of tachometers, temperature indicators, and fuel flow indicators. Checking includes the inspection of physical condition, operation, and calibration of the instruments. Although the mechanic may be limited in performing field repairs on these instruments, specially trained repairmen are employed by instrument repair shops to overhaul, repair, and test the instruments.

PRINCIPAL FINDINGS

N - Less than 10 percent of the airline mechanics work on these instrument systems.

F - The frequency with which mechanics work on electrical engine instruments is high in all industrial categories.

T - Airline overhaul stations indicate that the technical knowledge required to troubleshoot and replace tachometers and rate-of-flow indication systems and to inspect, test, and repair engine indicating system components is at the analysis level.

M - Airline overhaul stations indicate that the mechanic works under a time critical situation that requires no job planning for these same tasks.

I - Airline line stations provide in-depth training for these same tasks, although industry generally provides training at the basic or general information level.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. In addition, the committee recommended that another subtopic titled "Inspect, test and repair electrical connectors" be added to the core curriculum. It was generally agreed that this added subtopic is often neglected and that its importance justifies its inclusion in the core curriculum. This new subtopic is listed in the core curriculum on page 183.

TABLE 16. AIRCRAFT FUEL AND OIL MEASUREMENT AND CONTROL

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
PERFORM FUEL MANAGEMENT, TRANSFER AND DEFUELING	+	-	+	+	H	H	H	H	3	4	3	3	3	3	3	3	3	4	3	3
TROUBLE SHOOT AND REPLACE																				
FUEL AND OIL ELECTRIC PUMPS, VALVES AND THEIR CONTROLS	$	$	+	+	H	H	H	H	3	2	3	3	4	3	3	3	3	3	3	3
FLUID QUANTITY INDICATION SYSTEMS	-	-	+	+	H	H	H	H	3	4	3	3	2	3	3	3	4	4	3	3
FLUID PRESSURE AND TEMPERATURE INDICATION SYSTEMS	-	-	+	+	H	H	H	H	3	3	3	3	2	3	3	3	3	3	3	3
FLUID SYSTEM WARNING DEVICES	-	-	+	+	H	H	H	H	3	2	3	3	2	3	3	3	3	4	3	3
CALIBRATE AND TEST																				
CAPACITANCE FUEL AND OIL QUANTITY INDICATION SYSTEMS	-	-	+	+	H	H	H	H	3	4	3	3	2	3	3	3	4	4	3	1
FLOAT TYPE FUEL AND OIL QUANTITY INDICATION SYSTEMS		-	+	+	H	H	H	H	3	2	3	3	3	3	3	3	3	3	3	3
INSPECT AND REPAIR																				
FUEL AND OIL PUMPS, VALVES AND OTHER CONTROL UNITS		-	+	+	H	H	H	H	5	3	3	3	4	2	3	3	4	3	3	3
FLUID QUANTITY INDICATION EQUIPMENT	-		+	+	H	H	H	H	3	4	3	3	2	4	3	3	4	3	3	3
PRESSURE AND TEMPERATURE INDICATION AND WARNING SYSTEMS	-		+	+	H	H	H	H	3	4	3	3	2	4	3	3	3	3	3	3
TROUBLE SHOOT AND REPLACE																				
PRESSURE REFUELING CONTROL EQUIPMENT	-	-	+	$	H	H	H	L	3	3	3	3	4	3	3	3	3	4	3	3

TABLE 16

AIRCRAFT FUEL AND OIL MEASUREMENT AND CONTROL

OVERVIEW OF WORK PERFORMED

Mechanics must be familiar with fuel and oil pumps, valves and controls, quantity indication systems, warning systems, pressure- and temperature-indicating systems, refueling and defueling systems, and fuel transfer systems. They are required to have this knowledge because they are regularly called upon to service and maintain this equipment. In addition, mechanics must be able to troubleshoot these systems, perform necessary repairs, and conduct routine inspections. Mechanics performing calibration tests on fluid quantity indication systems must exercise utmost care in preventing foreign objects from entering and remaining in fuel or oil tanks. Mechanics remove, install, and repair components of these systems and must be familiar with the mechanical rigging required between controls, valves, and switches.

PRINCIPAL FINDINGS

N - Less than 5 percent of the airline mechanics perform most of these tasks.

F - The rate of frequency with which mechanics work on aircraft fuel and oil measurement and control equipment is high in all categories.

T - Airline line stations indicate that the technical knowledge of mechanics should be at the synthesis level for inspecting and repairing fuel and oil pumps, valves, and other control units. Airline overhaul mechanics perform many of these tasks at the analysis level.

I - Training in depth is offered by the airline industry in many of the subtopics.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee recommended deleting manipulative skill training from these subtopics,"Inspect and repair fluid quantity indication equipment," and "Troubleshoot and replace pressure refueling control equipment." These recommendations are made on the basis of equipment availability and costs involved. An overview lecture on these subtopics is considered to be adequate.

TABLE 17. AIRCRAFT LANDING GEAR ELECTRICAL UNITS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
TROUBLE SHOOT LANDING GEAR POSITION INDICATION AND WARNING SYSTEMS	-	-	+	+	H	H	H	H	3	3	4	3	2	5	3	3	3	4	3	3
CHECK AND TROUBLE SHOOT GROUND—FLIGHT CHANGEOVER SWITCHES AND RELAYS	-	-	+	+	H	H	H	H	3	3	4	3	2	5	3	3	3	4	3	3
CHECK TAKEOFF WARNING SYSTEMS	-	-	+	+	H	H	H	H	3	3	4	3	2	2	3	2	3	4	3	3
INSPECT, TEST AND REPLACE																				
SPEED WARNING COMPONENTS	-	-	+	+	H	H	H	H	3	3	4	3	2	3	3	3	3	4	3	3
TAKE-OFF WARNING COMPONENTS	-	-	+	+	H	H	H	H	3	3	4	3	2	3	3	3	3	4	3	1
LANDING GEAR AND GEAR DOOR SWITCHES	-	-	+	+	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	3
GROUND-FLIGHT SWITCHES AND RELAYS	-	-	+	+	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	1
CHECK AND TROUBLE SHOOT ELECTRICAL BRAKE CONTROLS AND ANTI-SKID CONTROL SYSTEMS	-	-	+	$	H	H	H	H	3	4	4	3	2	2	3	3	3	4	3	1
INSPECT, TEST AND REPLACE																				
ANTI-SKID CONTROL COMPONENTS	-	-	+	-	H	H	H	H	3	3	4	3	2	3	3	3	3	4	3	3

TABLE 17

AIRCRAFT LANDING GEAR ELECTRICAL UNITS

OVERVIEW OF WORK PERFORMED

Mechanics inspect, service, and repair aircraft landing gear retract systems, warning systems, and position indicators. The electrical control of retractable landing gear and anti-skid devices must operate perfectly if serious aviation accidents are to be prevented. The testing and replacement of warning systems, change-over relays, and landing gear position indicators are but a few of the tasks performed.

PRINCIPAL FINDINGS

N - Less than 5 percent of the airline industry mechanics perform these tasks.

F - The frequency at which aviation mechanics work with landing gear electrical units is high.

T - Mechanics employed by large general aviation companies indicate that they must analyze system malfunctions and troubleshoot most of the tasks identified in this table.

M - Airline overhaul mechanics indicate that troubleshooting landing gear indication and position warning systems, along with flight change-over switches and relays, requires job planning under critical time conditions.

I - Airline mechanics employed at the overhaul bases are trained in depth in all subtopics.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended that the inspection, testing, and replacement of anti-skid control components be deleted from the aviation mechanics core curriculum because of specialization and high cost of equipment. All other subtopics should be included. The teaching level for the subtopic titled "Check takeoff warning systems" need not include manipulative skill training.

TABLE 18. FIRE DETECTION AND EXTINGUISHING SYSTEMS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND SERVICE																				
BIMETALLIC, THERMOCOUPLE AND CONTINUOUS STRIP FIRE DETECTION SYSTEMS	$	–	+	+	H	H	H	H	1	3	3	3	2	3	3	3	3	4	3	3
FIRE EXTINGUISHING SYSTEMS	$	–	+	+	H	H	H	H	1	3	3	3	2	3	3	3	3	4	3	1
INSPECT, REPLACE OR REPAIR																				
COMPARTMENT FIRE DETECTORS AND SYSTEM COMPONENTS	$	–	+	+	H	H	H	L	2	3	3	3	3	3	2	3	3	3	3	3
FIRE EXTINGUISHERS AND RELATED SYSTEM COMPONENTS	$	–	+	+	H	H	H	H	3	3	3	3	3	2	2	3	3	4	3	3
ENGINE AND NACELLE FIRE DETECTION COMPONENTS	–	–	+	+	H	H	H	L	2	3	3	3	2	3	2	3	3	3	3	3
CHECK AND SERVICE																				
SMOKE AND CARBON MONOXIDE DETECTION SYSTEMS	$		+	$	H	H	H	L	1	3	3	3	2	4	3	3	3	3	3	3
INSPECT, REPLACE OR REPAIR																				
SMOKE DETECTION COMPONENTS	$		+	–	H	H	H	H	3	3	3	4	3	5	3	3	2	4	3	3

TABLE 18

FIRE DETECTION AND EXTINGUISHING SYSTEMS

OVERVIEW OF SYSTEMS AND WORK PERFORMED

Fire detection and extinguishing systems require periodic servicing, checking, and maintenance. The mechanic must be familiar with the operation of these systems so that he may perform necessary inspection of all components, such as valves, sensors, indicators, extinguishing material containers, electrical wires, and plumbing. These systems also require troubleshooting in the event of a component malfunction, and the mechanic should be familiar with installation, removal or replacement procedures, and operational checking of the system or components.

PRINCIPAL FINDINGS

N - Less than 5 percent of airline overhaul mechanics accomplish these tasks.

F - Airline mechanics and mechanics employed by large general aviation companies perform work on fire detection and extinguishing systems at a high rate of frequency. Mechanics employed by small general aviation companies perform these tasks at a lower rate of frequency, since most light aircraft do not incorporate fire detection and extinguishing systems.

T - Airline line stations indicate that they require the technical knowledge of mechanics to be only at the knowledge level for checking and servicing these systems.

M - Airline overhaul stations indicate that time is critical and job planning is required to accomplish the task of inspecting, replacing, or repairing smoke detection components.

I - Airline overhaul stations provide in-depth training in most of the subtopics, while industry generally provides training at the basic or general information level.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. Manipulative skill training is not recommended for checking and servicing fire extinguishing systems. The committee recommended that a technical overview lesson on this subject be provided. The committee believed that specific knowledge of an individual system would not be as beneficial to the student as a broad technical lecture/discussion of this subject.

TABLE 19. ICE AND RAIN CONTROL

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND SERVICE																				
POWERPLANT ICE CONTROL SYSTEMS	$	-	+	+	H	H	H	H	4	3	3	3	4	2	2	3	2	4	3	3
AIR SCOOPS AND LEADING EDGE ICE CONTROL SYSTEMS	$	-	+	+	H	H	H	H	4	3	3	3	4	2	2	2	2	4	3	3
ELECTRICAL WINDSHIELD ICE CONTROL SYSTEMS	$	-	+	+	H	H	H	L	3	3	3	3	4	4	2	3	4	4	3	1
INSPECT AND REPAIR																				
POWERPLANT ICE CONTROL COMPONENTS	$		+	+	H	H	H	H	4	3	3	3	3	2	2	3	3	4	3	3
CHECK AND SERVICE																				
ANTENNAS, ACCESSORIES AND PITOT STATIC DEVICES	-	-	+	+	H	H	H	H	3	3	3	3	2	4	2	3	3	4	3	3
TROUBLE SHOOT AND REPAIR WINDSHIELD RAIN REMOVAL AND WINDOW DEFOGGING SYSTEMS	-	-	+	+	H	H	H	H	4	3	3	3	5	2	3	3	3	4	3	1
INSPECT AND REPAIR																				
AIR SCOOPS AND LEADING EDGE ICE CONTROL SYSTEMS	-	-	+	+	H	H	H	H	4	3	3	3	3	2	2	3	3	4	3	1
WINDSHIELD ICE CONTROL SYSTEMS	-		+	+	H	H	H	L	4	2	3	3	4	2	2	3	3	2	3	1
CHECK AND SERVICE																				
PNEUMATIC WINDSHIELD ANTI-ICING AND DEFOGGING SYSTEMS			+	+	H	H	H	H	3	3	3	3	3	2	2	3	2	4	3	1

TABLE 19

ICE AND RAIN CONTROL

OVERVIEW OF WORK PERFORMED

Both anti-icing and de-icing systems are essential to air safety. Mechanics service, maintain, and check out these systems. Ice and rain control systems include pneumatic de-icer boots; thermal anti-icing; parting strip heaters; calrod heaters on scoops, etc.; powerplant ice control; and windshield de-fogging and de-icing equipment. Ice detectors are also serviced.

PRINCIPAL FINDINGS

N - Less than 10 percent of all airline mechanics perform these tasks.

F - Mechanics employed by small general aviation companies rarely service electrically heated windshields.

T - Airline line mechanics generally work at the analysis level.

M - Airline mechanics are under time limitations when performing many of the tasks identified in this table.

I - Airline overhaul mechanics receive industry training in depth in the majority of these subtopics. Mechanics employed by small general aviation companies receive little training in this subject area.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum, but the subtopic titled "Check and service powerplant ice control systems" need not include manipulative skill training. The committee believed that specific knowledge of an individual system would not be as beneficial to the student as a broad technical lecture/discussion of this subject.

TABLE 20. WARNING SYSTEMS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND SERVICE																				
HYDRAULIC POWER AND SYSTEM COMPONENTS	–	–	+	+	H	H	H	H	3	3	3	3	2	3	2	3	3	4	3	3
ICE AND RAIN PROTECTION	–	–	+	+	H	H	H	H	3	3	3	3	2	3	2	2	3	4	3	1
LIGHTS AND LIGHTING	–	–	+	+	H	H	H	H	3	3	3	3	2	3	2	2	3	4	3	3
DOORS AND EMERGENCY WINDOWS	–	–	+	+	H	H	H	H	3	3	3	3	2	3	2	2	3	4	3	3
FLIGHT CONTROLS, FLAPS, SPOILERS AND LEADING EDGE DEVICES	–	–	+	+	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	3
POWERPLANT STARTING AND VIBRATION	–	–	+	+	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	3
OVERSPEED AND UNDERSPEED	–	–	+	+	H	H	H	L	3	3	3	3	2	3	2	3	3	4	3	3
ELECTRICAL, PNEUMATIC AND OXYGEN SYSTEMS	–	–	+	+	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	3
INSPECT AND REPAIR WARNING SYSTEM COMPONENTS			+	+	H	H	H	H	4	3	3	3	4	2	3	3	4	4	3	3

TABLE 20

WARNING SYSTEMS

OVERVIEW OF WORK PERFORMED

A warning system may give flight crews or pilots their first indication of a malfunction. Significant is the growing availability of small, fast piston- and turbine-powered aircraft in the general aviation fleet, which incorporate warning systems. Mechanics service and repair warning systems, such as door warning; power failure warning; fuel, oil and hydraulic low pressure warning; stall warning; and over- or under-speed warning. Some aircraft employ vibration detection indicators.

PRINCIPAL FINDINGS

N - Less than 5 percent of all airline mechanics perform these tasks.

F - In all categories, their mechanics perform these tasks at a high rate of frequency.

M - Airline line station mechanics may be required to inspect and repair warning system components under critical time limitations.

I - Airline overhaul mechanics are trained in depth in all subtopics. Airline line mechanics are trained in depth to inspect and repair warning system components.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee recommended teaching to the comprehension level for all subtopics except "Inspection and repair of warning system components" where teaching to the knowledge level would be adequate.

TABLE 21. RECIPROCATING ENGINES

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY TYPES AND PRINCIPLES OF RECIPROCATING POWERPLANTS	+	−	+	+	H	H	H	H	1	3	3	3	2	5	1	3	4	3	4	1
CHECK AND SERVICE																				
FOURTEEN CYLINDER RADIAL ENGINE OR LARGER	+		+	+	H	H	H	H	1	4	3	3	3	5	3	3	3	4	4	3
INSPECT AND REPAIR																				
FOURTEEN CYLINDER RADIAL ENGINE OR LARGER	+		+	+	H	H	H	H	4	4	4	3	3	5	3	3	3	4	4	3
REMOVE AND INSTALL ENGINE	+		+	+	L	H	H	H	3	3	3	3	3	5	3	3	4	4	3	3
CHECK AND SERVICE																				
CYLINDER	$		+	+	H	H	H	H	2	4	3	3	3	5	3	3	3	4	3	3
INSPECT AND REPAIR																				
CYLINDER	$		+	+	H	H	H	H	4	4	4	3	3	5	3	3	4	4	3	3
GEAR REDUCTION SECTION	−		+	+	H	H	H	H	1	4	4	3	2	5	3	3	4	4	3	3
SUPERCHARGER	−		+	+	H	H	H	H	3	4	4	3	3	5	3	3	4	4	3	3
TROUBLE SHOOT	−		+	+	H	H	H	H	3	4	4	3	3	5	3	3	4	4	3	3
OPERATE ENGINE	−		+	+	H	H	H	H	3	4	3	3	4	5	3	3	4	4	3	3
INSPECT AND REPAIR																				
FOUR OR SIX CYLINDER OPPOSED ENGINE			+	+			H	H			3	3			3	3			3	3
SEVEN OR NINE CYLINDER RADIAL ENGINE			+	+			H	H			3	3			3	3			3	3

TABLE 21

RECIPROCATING ENGINES

OVERVIEW OF WORK PERFORMED

Since the advent of aviation, reciprocating engines have undergone innumerable changes to achieve their present reliability. Although turbine engines are now finding more and varied use in aviation, the reciprocating engine is still in great demand. The aviation mechanic must understand the theory of reciprocating engine operation and possess the maintenance skills needed to maintain these aircraft powerplants. He must be capable of operating, interpreting trouble reports, servicing, troubleshooting, and overhauling these engines.

PRINCIPAL FINDINGS

N - Less than 2 percent of airline overhaul mechanics work on reciprocating engines.

F - Mechanics working on reciprocating engines perform their jobs at a high rate of frequency. Airline line mechanics infrequently remove and install reciprocating engines. Radial engines of seven or more cylinders are overhauled infrequently by small general aviation companies. The airline mechanics, on the other hand, do not work with small reciprocating engines.

M - Airline overhaul mechanics work under critical time limitations requiring job planning. Airline mechanics generally receive training in depth regarding cylinders, gear reduction sections, superchargers, and troubleshooting and operating reciprocating engines. Large general aviation offers training in depth for the overhaul of all reciprocating engines.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The subtopic "Identify types and principles of reciprocating powerplants" should not include manipulative skill.

TABLE 21. RECIPROCATING ENGINES (CONTINUED)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
CHECK AND SERVICE																				
GEAR REDUCTION SECTION			+	+	H	H	H	H	1	4	3	3	2	3	3	3	3	4	3	3
SUPERCHARGER			+	+	H	H	H	H	1	4	3	3	2	3	3	3	3	4	3	3
FOUR OR SIX CYLINDER OPPOSED ENGINE			+	+			H	H			3	3			3	3			3	3
SEVEN OR NINE CYLINDER RADIAL ENGINE			+	+			H	H			3	3			3	3			3	3
OVERHAUL																				
FOUR OR SIX CYLINDER OPPOSED ENGINE			+	+			H	H			3	3			3	3			4	3
SEVEN OR NINE CYLINDER RADIAL ENGINE			+	+			H	L			3	3			3	3			4	3
CYLINDER			+	+	H	H	H	H	3	4	3	3	3	5	3	3	4	4	4	3
GEAR REDUCTION SECTION			$	+	H	H	H	L	3	4	3	3	3	5	3	3	4	4	4	3
SUPERCHARGER			$	+	H	H	H	L	3	3	3	3	3	5	3	3	4	3	4	4
FOURTEEN CYLINDER RADIAL ENGINE OR LARGER			$	$		H	H	L		3	3	3		5	3	3		3	4	1

TABLE 22. TURBINE ENGINES

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY TYPES AND PRINCIPLES OF TURBINE ENGINES	+	–	+	+	H	H	H	H	3	5	3	3	3	5	1	1	4	3	3	1
REMOVE AND INSTALL ENGINE	+	–	+	+	H	H	H	L	4	3	3	3	5	5	3	3	4	4	3	1
INSPECT AND REPAIR																				
TURBOJET	+	+	+	–	H	H	H	H	5	4	3	3	3	3	3	3	3	4	3	3
CHECK AND SERVICE																				
ACCESSORIES	+	–	+	$	H	H	H	H	3	3	3	3	3	4	3	3	3	4	4	4
INSPECT AND REPAIR																				
ACCESSORIES	+		+	$	H	H	H	H	3	4	3	3	5	4	3	3	3	3	4	4
CHECK AND SERVICE																				
TURBOJET	+	–	+	–	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3
TROUBLE SHOOT	$		+	$	H	H	H	H	4	4	4	3	4	5	3	3	4	4	4	4
OPERATE ENGINE	$		+	$	H	H	H	H	3	4	3	3	5	4	3	3	3	4	4	4
CHECK AND SERVICE																				
TURBOFAN	+	–	$	–	H	H	H	H	3	3	2	3	3	3	3	3	3	4	4	3
OVERHAUL																				
TURBOJET	$	+	–		H	H	L	H	5	4	4	3	3	5	4	3	4	4	3	3
CHECK AND SERVICE																				
TURBOPROP			+	$	H	H	H	H	1	4	3	3	2	5	3	5	3	4	4	4
INSPECT AND REPAIR																				
TURBOPROP			+	$	H	H	H	H	1	4	3	3	2	5	3	5	3	4	4	4
TURBOFAN	+		$		H	H	H	H	5	4	3	3	3	5	3	3	3	4	4	3
OVERHAUL																				
TURBOFAN	$	–	–		H	H	L	H	5	1	4	3	3	5	4	3	4	3	3	3
ACCESSORIES	–		–		H	H	L	H	5	5	4	3	3	5	4	3	4	4	4	3
TURBOPROP				–		H	H	H		5	4	5		5	5	3		4	4	4

TABLE 22

TURBINE ENGINES

OVERVIEW OF WORK PERFORMED

The basic turbine engine and its operation is quite simple when compared to the reciprocating engine. Because of this simplicity, the turbine engine generally requires less maintenance and operates for greater periods of time between overhauls than does the reciprocating engine. The servicing of turbine engines can be more critical than reciprocating engines because of their characteristic operation at higher temperatures, pressures, speeds and power. The mechanic must know how to operate, troubleshoot, interpret discrepancy reports, service, and maintain these engines and their accessories. As more turbine engines are being introduced into aviation, the demand for more mechanics trained in turbine engines correspondingly increases.

PRINCIPAL FINDINGS

N - Less than 2 percent of airline mechanics check and service, inspect and repair, and overhaul turboprop engines.

F - The frequency at which mechanics work with turbine engines is high. Comparison of the results of this study with those of the California study conducted one year earlier indicates a heavy increase in the number of turbine engines now being used in general aviation.

T - General aviation indicated that the technical knowledge needed by mechanics is mostly at the application level, while the airlines indicated that the level was more at the analysis/synthesis level.

M - Many of the tasks are performed under pressure of time, and the mechanics are required to plan their job steps prior to performing them.

I - In-depth training is provided by all industrial categories in the troubleshooting of turbine engines in particular.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The subtopic "Identify types and principles of turbine engines" should not include manipulative skill training. The committee recommended that the overhaul of turbine engines during instruction may utilize parts and materials that would be adequate for the training situation but would not necessarily require that the engine be assembled to a return to flight condition. This does not mean that the quality of workmanship should be less than return to flight standards.

TABLE 23. LUBRICATING SYSTEMS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY TYPES OF LUBRICATION SYSTEMS	+	-	+	+	H	H	H	H	3	2	1	3	3	3	1	2	3	3	3	3
IDENTIFY TYPES AND SPECIFICATIONS OF LUBRICANTS	+	-	+	+	H	H	H	H	2	2	1	3	2	3	1	3	3	3	3	3
CHECK AND SERVICE																				
COOLERS AND TEMPERATURE REGULATORS	+	-	+	+	H	H	H	H	2	3	3	3	3	3	2	3	3	3	3	3
PUMPS AND VALVES	+	-	+	+	H	H	H	H	2	3	3	3	3	3	2	3	3	3	3	3
SEALS AND OTHER COMPONENTS	+	-	+	+	H	H	H	H	2	3	3	3	3	3	2	2	3	3	3	3
TANKS AND LINES	+	-	+	+	H	H	H	H	2	3	3	3	3	3	2	3	3	3	3	3
INSPECT AND REPAIR																				
COOLERS AND TEMPERATURE REGULATORS	+	-	+	+	H	H	H	H	2	3	3	3	3	3	2	3	3	3	4	3
PUMPS AND VALVES	+	-	+	+	H	H	H	H	2	3	3	3	3	3	3	3	3	3	4	3
TANKS AND LINES	+	-	+	+	H	H	H	H	2	3	3	3	3	3	3	3	3	3	3	3
SEALS AND OTHER COMPONENTS	+		+	+	H	H	H	H	2	3	3	3	3	5	3	3	3	3	3	3
ADJUST PRESSURE	+		+	+	H	H	H	H	3	4	3	3	2	3	3	3	3	4	3	3
INSPECT AND REPAIR																				
OIL DILUTION SYSTEM	-		+	+	H	H	H	L	3	3	3	3	3	3	2	3	3	3	3	3
CHECK AND SERVICE																				
OIL DILUTION SYSTEM	-		+	+	H	H	H	L	3	3	3	3	3	3	2	3	3	4	3	3

TABLE 23

LUBRICATING SYSTEMS

OVERVIEW OF WORK PERFORMED

Lubricating systems of both reciprocating and turbine engines must be maintained and serviced by mechanics. Such systems include engine components, accessories, coolers (radiators), tanks, lines, etc. The proper maintenance of the lubricating system will assist in providing normal engine operating temperatures and pressures so that the operating life of the powerplant is extended.

PRINCIPAL FINDINGS

N - Less than 5 percent of airline overhaul mechanics work on lubricating systems.

F - It will be noted that mechanics work on the lubricating systems at high frequency.

T - The technical knowledge level required by the airline line stations is generally at the comprehension level. The technical knowledge level required by airline overhaul stations and general aviation is primarily at the application level.

M - Airline overhaul stations indicate that time is critical and that the mechanic must utilize job planning during his task of inspecting and repairing seals and other components.

I - In most of the tasks performed, industry training is at the basic or general information level. Large general aviation provides training in depth for the inspection and repair of coolers and temperature regulators, pumps and valves, while airline overhaul stations provide in-depth training for adjusting pressure and checking and servicing oil dilution systems.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 24. IGNITION SYSTEMS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY SPECIAL DANGERS OF HIGH ENERGY SYSTEMS	+	+	+	+	H	H	H	H	4	3	3	3	3	1	3	3	3	3	4	1
CHECK AND SERVICE																				
TURBINE IGNITION SYSTEMS	+		+	+	H	H	H	H	4	3	3	3	3	4	2	3	3	3	3	1
LOW TENSION SYSTEMS	$		+	+	H	H	H	H	3	3	3	3	3	5	2	3	3	4	3	3
INSPECT AND REPAIR																				
LOW TENSION SYSTEMS	$		+	+	H	H	H	H	3	4	4	3	3	3	3	3	3	4	3	3
BOOSTER STARTING SYSTEMS	$		+	+	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	1
TURBINE IGNITION SYSTEMS	+		+	$	H	H	H	H	4	3	3	3	3	3	3	3	3	4	4	4
CLASSIFY TYPES OF MAGNETOS	-		+	+	H	H	H	H	3	3	1	3	3	1	1	3	4	4	3	1
CHECK AND SERVICE																				
BOOSTER STARTING SYSTEMS	-		+	+	H	H	H	H	1	2	3	3	2	2	2	3	3	3	3	3
BATTERY IGNITION SYSTEMS			+	+	H		H	L	3		3	3	3		2	3	4		3	3
HIGH TENSION SYSTEMS			+	+	H		H	H	1		3	3	3		2	3	2		3	3
INSPECT AND REPAIR																				
BATTERY IGNITION SYSTEMS			+	+	H		H	L	3		3	3	3		3	3	4		3	3
HIGH TENSION SYSTEMS			+	+	H		H	H	1		3	3	2		3	3	3		3	3

TABLE 24

IGNITION SYSTEMS

OVERVIEW OF WORK PERFORMED

Ignition systems consist of high energy producing devices, magnetos, booster coils, spark plugs, distributors, and harnesses. These components require maintenance in the form of repairs, servicing, removal, proper timing, and installation associated with reciprocating and/or turbine engines.

PRINCIPAL FINDINGS

N - With the exception of identifying special dangers of high energy systems, less than 2 percent of airline overhaul mechanics work on ignition systems.

F - With the exception of airline overhaul mechanics who do not check, service, inspect or repair battery ignition and high tension systems, mechanics in all categories work on ignition systems at high frequency.

T - Mechanics employed at airline line stations indicate that the technical knowledge for turbine ignition systems is at the analysis level.

I - Airline overhaul stations provide in-depth training to their mechanics in ignition systems, with the exception of battery and high tension ignition systems where no training is provided.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics, except "Classify types of magnetos," "Check and service battery ignition systems," and "Inspect and repair battery ignition systems," should be included in the aviation mechanics core curriculum. The identified subtopics have been recommended for deletion on the basis of obsolescence and the basis that the time would be better spent in the teaching of turbine engine ignition systems.

TABLE 25. FUEL METERING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INSPECT, MAINTAIN, AND TEST																				
GAS TURBINE FUEL CONTROL UNITS	+		+	+	H	H	H	H	4	3	3	3	3	4	3	3	3	4	4	1
ADI SYSTEMS	$		+	+	L	H	H	H	3	3	3	3	3	3	2	3	3	3	4	1
CARBURETOR DE-ICING AND ANTI-ICING	$		+	+	H	H	H	H	3	3	3	3	3	3	2	3	3	3	3	3
CHECK AND SERVICE WATER INJECTION SYSTEM	+		+	$	H	H	H	H	4	4	1	3	3	4	2	3	3	4	3	3
DETERMINE CAUSES OF DETONATION, AUTO IGNITION, ETC.	-		+	+	H	H	H	H	3	3	4	3	4	1	3	3	3	4	3	1
INSPECT, MAINTAIN, AND TEST																				
FLOAT CARBURETORS	-		+	+	L		H	H	3		3	3	3		3	3	3		3	3
INJECTION CARBURETORS	-		+	+	L	H	H	H	3	1	3	3	3	3	3	3	3	4	4	3
INJECTION NOZZLES	-		+	+	L	H	H	H	3	1	3	3	3	3	2	3	3	4	4	3
TRIM TURBINE POWERPLANTS	$		+	$	H	H	H	L	3	3	4	3	5	3	3	3	4	4	4	3

TABLE 25

FUEL METERING

OVERVIEW OF WORK PERFORMED

Fuel metering systems for reciprocating and turbine engines basically consist of fuel tanks, pumps, fuel controls, pressurizing and drain valves, carburetors or master controls, water injection controls, de-icing and anti-icing systems, injection nozzles, and associated plumbing.

Mechanics inspect, service, and maintain these fuel metering and carburetion systems. Generally, fuel metering and control systems are quite complex, with the fuel metering and control components requiring special test equipment for proper calibration. Mechanics do not repair fuel control units in the field, but they must understand the operation of and be capable of troubleshooting the fuel metering system on a turbine or reciprocating engine.

PRINCIPAL FINDINGS

N - Less than 2 percent of airline overhaul mechanics work on fuel metering systems.

F - Except for airline line station mechanics, who infrequently work on carburetors, injection nozzles, and anti-detonant injection systems, mechanics in all categories work at a high rate of frequency in the areas of fuel metering. Mechanics employed by small aviation companies work at a low rate of frequency in the area of "trimming" turbine powerplants. (This will increase with the introduction of greater numbers of turbine engine aircraft in general aviation.)

T - The technical knowledge required by airline line stations for "Inspect, maintain, and test gas turbine fuel control units" and all airline mechanics when checking and servicing water injection systems is at the analysis level. The same knowledge level is required by large general aviation for "trim turbine powerplants" and determining causes of detonation, auto ignition, etc.

I - Training in depth is given by airline overhaul stations and large general aviation in the areas of gas turbine fuel control units, injection carburetors and nozzles, and the trimming of turbine powerplants.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 26. INDUCTION SYSTEM

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INSPECT AND MAINTAIN																				
CARBURETOR INTAKE AND INTAKE PIPES	$		+	+	H	H	H	H	3	3	3	3	3	2	2	3	3	3	3	3
HEAT EXCHANGERS	$		+	+	L	H	H	H	3	3	3	3	3	2	2	3	3	3	3	3

TABLE 26

INDUCTION SYSTEM

OVERVIEW OF WORK PERFORMED

The induction system generally refers to reciprocating engines and consists of air intake scoops, pipes, superchargers, and heat exchangers.

Mechanics perform inspection, installation, removal, and maintenance of the induction system. Maintenance includes checking the system for security and leakage to prevent fires and for improper operation of the engine.

PRINCIPAL FINDINGS

N - Less than 2 percent of airline overhaul mechanics work on induction systems.

F - Except for the inspection and maintenance of heat exchangers by airline line stations, the rate of frequency for mechanics performing induction system tasks is high in all categories.

T - The technical knowledge required for all categories is at the application level.

M - Airline line stations and small general aviation show a manipulative skill level where the mechanic has a reasonable time limit and requires job planning to perform the tasks on the induction system.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 27. PROPELLER (GENERAL)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
PERFORM SPECIALIZED PROPELLER INSPECTIONS	-		+	+	H	H	L	H	3	3	4	3	2	5	3	3	3	4	4	3
PERFORM PROPELLER TRACK	-		+	+	H	L	L	H	3	4	3	3	4	3	2	3	3	3	3	3
USE UNIVERSAL PROTRACTOR	-		+	+	H	H	H	H	3	3	3	3	4	3	3	3	3	4	3	3
APPLY THEORY OF THRUST			+	+	H	H	H	H	4	3	1	3	4	2	1	3	3	3	4	3
USE PROPELLER SPECIFICATIONS			+	+	L	H	H	H	3	1	3	3	4	2	1	3	3	3	4	3
APPLY THEORY OF BALANCE			+	+	L	H	H	L	3	3	3	3	3	2	3	3	3	3	3	3
IDENTIFY SPECIAL PROPELLER LUBRICANTS			+	+	H	L	H	H	1	4	1	3	2	3	1	3	3	3	3	3

TABLE 27

PROPELLER (GENERAL)

OVERVIEW OF WORK PERFORMED

Propellers require inspection and maintenance, and these tasks are performed by the mechanic in accordance with manufacturer's and FAA specifications. Mechanics perform removal, installation, and tracking, and must understand operating instructions and procedures. In many situations the mechanic must use special tools to accomplish his job on a propeller assembly.

PRINCIPAL FINDINGS

N - Less than 2 percent of the airline mechanics perform general propeller work, with the exception of airline line mechanics working to inspect, track and use a universal protractor.

F - An understanding of the theory of thrust and skill in the use of a propeller protractor is frequently required of mechanics, regardless of industrial category.

M - Airline line mechanics accomplish most of the tasks identified in this table under critical time limitations.

I - Although industry training is primarily to the basic or general information level, airline overhaul stations and large general aviation companies provide in-depth training in selected subtopics.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

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TABLE 28. FIXED PITCH PROPELLERS (WOOD)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
REMOVE AND INSTALL			+	+			L	L			3	3			3	3			3	3
REFINISH PROPELLER			$	+			L	L			1	3			3	3			3	3
BALANCE VERTICAL AND HORIZONTAL			-	+			L	L			3	3			3	3			3	3

TABLE 29. FIXED PITCH PROPELLERS (METAL)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
REPAIR PROPELLER (MINOR)			+	+		H	H	H		3	3	3		3	3	3		2	3	3
REMOVE AND INSTALL			+	+			H	H			3	3			3	3			3	3
REFINISH PROPELLER			$	+			H	H			3	3			3	2			3	3
BALANCE VERTICAL AND HORIZONTAL			$	+		H	L	H		3	3	3		3	3	3		2	3	3

TABLE 28

FIXED PITCH PROPELLERS (WOOD)

TABLE 29

FIXED PITCH PROPELLERS (METAL)

OVERVIEW OF WORK PERFORMED

Mechanics remove, inspect, balance, refinish and install metal and wood fixed pitch propellers. Minor repairs to metal fixed pitch propellers are also performed by mechanics.

PRINCIPAL FINDINGS

N - Less than 2 percent of airline mechanics work on metal propellers and none works on wooden propellers.

F - General aviation mechanics perform work on fixed pitch wood propellers at a low frequency rate, while they work on fixed pitch metal propellers at a high rate of frequency. Airline overhaul mechanics frequently balance and accomplish minor repairs to fixed pitch metal propellers.

T - The technical knowledge required of the mechanic accomplishing these tasks is primarily at the application level.

I - Airline line mechanics receive no training in the subtopics identified.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 30. GROUND ADJUSTABLE PROPELLERS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
REMOVE AND INSTALL			+	+			H	L			3	3			3	3			3	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			$	+			L	L			3	3			3	3			3	3
REPAIR BLADES AND HUB (MINOR)			$	+			H	H			3	3			3	3			3	3
REPITCH PROPELLER			$	+			L	L			3	3			3	3			3	3
BALANCE			–	+			L	L			3	3			3	3			3	3

TABLE 30

GROUND ADJUSTABLE PROPELLERS

OVERVIEW OF WORK PERFORMED

Currently there are no ground adjustable propellers being manufactured. The ground adjustable propeller is still in existence in general aviation, but in decreasing numbers since 1931. The aviation mechanic may be expected to perform the associated tasks of maintaining and servicing this type of propeller.

PRINCIPAL FINDINGS

N - No airline mechanics perform work on ground adjustable propellers. Only in small general aviation do more than 10 percent of the mechanics work to perform the tasks identified by all the subtopics.

F - This type of propeller is not found in the airline industry and the frequency at which general aviation mechanics work on this propeller is generally low.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

Training in ground adjustable propellers has been recommended for deletion from the aviation mechanics core curriculum because of the continued decrease in the use of this type of propeller. Equivalent manipulative skills and technical knowledge can be gained by the student during his training on other types of propellers.

TABLE 31. TWO POSITION AND CONSTANT SPEED PROPELLERS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
APPLY THEORY OF OPERATION			+	+			H	L			3	3			1	3			3	3
REMOVE AND INSTALL			+	+			H	H			3	3			3	3			3	3
CHECK OPERATION			+	+			H	H			3	3			3	3			3	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			$	+			H	L			3	3			3	3			3	3
BALANCE PROPELLER			-	+			L	L			3	3			3	3			3	3
OVERHAUL PROPELLER			-	$			L	L			3	3			3	3			4	3

TABLE 31

TWO POSITION AND CONSTANT SPEED PROPELLERS

OVERVIEW OF PROPELLER OPERATION AND WORK PERFORMED

Two position propellers operate in either a low pitch position or a high pitch position. Generally, the low pitch position is used during take-off conditions and the high pitch position is used for cruise or maximum speed conditions. Constant speed propellers are manually controlled to maintain a particular desired engine speed.

Mechanics working on these types of propellers are required to perform tasks in accordance with manufacturer's or FAA specifications for removal, installation, checking operation, disassembly, and assembly. Overhaul and balancing of these propellers is usually performed by specialized propeller shops or repair stations employing the required tools and equipment.

PRINCIPAL FINDINGS

N - Only general aviation mechanics indicated that they worked on two position and constant speed propellers.

F - General aviation mechanics frequently remove, install, and check operation, but the frequency rate for balancing and overhauling this type of propeller is low.

I - Large general aviation companies that overhaul this type of propeller indicate that they provide in-depth training for this task.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

With the exception of propeller balancing and overhaul, all other subtopics should be included in the aviation mechanics core curriculum. These two subtopics were recommended for deletion because of the low frequency with which these jobs are being performed by mechanics. The committee observed that this work is being done by specialty shops.

TABLE 32. CONSTANT SPEED FEATHERING PROPELLERS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
APPLY THEORY OF OPERATION			+	+	H	H	H	L	3	3	3	3	2	3	1	3	3	4	4	1
REMOVE AND INSTALL			+	+	H	H	H	H	1	3	3	3	2	3	3	3	3	3	3	3
CHECK OPERATION			+	+	H	H	H	H	1	3	3	3	2	3	3	3	3	4	3	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			$	+	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	3
BALANCE PROPELLER			$	+		H	H	H		3	3	3		3	3	3		4	3	3
OVERHAUL PROPELLER			-	$	H	H	H	L	3	3	3	3	3	3	3	3	3	4	4	3

TABLE 32

CONSTANT SPEED FEATHERING PROPELLERS

OVERVIEW OF PROPELLER OPERATION AND WORK PERFORMED

This type of propeller, in addition to maintaining a selected constant engine speed by varying its blade angle (pitch), has the capability of being fully feathered. Full feathering is used during an engine shut-down on multi-engined aircraft to minimize drag of the shut-down engine and propeller.

Mechanics working on this type of propeller must be familiar with and able to comply with instructions and specifications supplied by the manufacturer or the FAA. The tasks associated with constant speed feathering propellers include removal, installation, checking or operation, disassembly, and assembly. Balancing and overhaul of this type propeller is accomplished in specialized shops.

PRINCIPAL FINDINGS

N - The number of airline mechanics involved in maintaining constant speed feathering propellers is less than 2 percent.

F - Mechanics in all industrial categories report that they work on this type of propeller at a high rate of frequency.

I - Industry training provided by airline overhaul stations is at the in-depth training level.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

With the exception of balancing and overhauling this type of propeller, all other subtopics should be included in the aviation mechanics core curriculum. The committee recommended deleting these subtopics because of the specialization of the tasks, and because specialized shops doing this type of work generally provide industry training for their employees.

TABLE 33. REVERSIBLE PROPELLERS (RECIPROCATING ENGINES)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
APPLY THEORY OF OPERATION	-		+	$	H	H	H	L	3	4	1	3	2	3	1	3	3	4	4	1
REMOVE AND INSTALL	-		+	$	L	H	H	L	2	3	2	3	5	3	3	3	3	4	4	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS	-		-	-	L	H	L	L	3	1	3	3	5	3	3	3	3	4	4	1
OVERHAUL PROPELLER				-	L	H	L	L	4	1	4	3	4	3	4	3	4	4	4	1

TABLE 33

REVERSIBLE PROPELLERS (RECIPROCATING ENGINES)

OVERVIEW OF PROPELLER OPERATION AND WORK PERFORMED

This type of propeller, in addition to being fully featherable, incorporates the added feature of being able to be positioned into a reverse pitch condition. The reverse pitch position is used during the landing roll to aid in decreasing the forward speed of the aircraft. Reciprocating engines tend to overheat during propeller reverse pitch operation and are, therefore, timewise limited during this mode of operation.

Mechanics performing service or maintenance on reversible pitch propellers must be able to remove, install, check operation, disassemble, and assemble them in accordance with manufacturer's and/or FAA specifications. While the balancing and overhaul of these propellers are done in airline propeller shops or certificated propeller repair stations, mechanics are required to diagnose propeller malfunctions and make proper repairs.

PRINCIPAL FINDINGS

N - Less than 2 percent of the mechanics employed by the airline overhaul stations perform these tasks. Fewer than 10 percent of the mechanics employed by small general aviation companies work on reversible propellers.

F - The very limited number of airline overhaul mechanics who do this work report that they work at a high rate of frequency, while the airline line mechanic works at a low rate of frequency.

M - Mechanics employed at airline line stations indicate that time is critical and job planning is required when they are removing, installing, disassembling, or assembling these propellers.

I - In-depth industry training is provided to those mechanics employed at airline overhaul stations and by large general aviation companies.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics, except "Overhaul propeller," should be included in the aviation mechanics core curriculum. The committee recommended deleting this subtopic due to specialization of the task and the training provided by industry.

TABLE 34. REVERSIBLE PROPELLERS (TURBINE ENGINES)

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
APPLY THEORY OF OPERATION			$	$	H	H	H	L	3	3	3	3	2	2	3	3	3	4	4	1
REMOVE AND INSTALL	-		$	-	H	H	H	L	1	4	3	3	2	3	3	3	3	4	4	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			-	-	H	H	H	H	3	3	4	3	2	3	3	3	3	4	4	3
OVERHAUL PROPELLER				-	L	H	L	L	5	1	4	3	4	3	4	3	4	4	4	1
CHECK AND SERVICE TURBOPROP ENGINE BRAKE			-		L	H	L	L	2	3	1	3	4	3	3	3	3	4	4	4

TABLE 34

REVERSIBLE PROPELLERS (TURBINE ENGINES)

OVERVIEW OF PROPELLER OPERATION AND WORK PERFORMED

This type of propeller may also be fully feathered and can be placed in a reverse pitch position to assist in decelerating the aircraft. The turbine engine does not rely upon propeller air blast for cooling; therefore, reverse pitch can be utilized for greater periods of time and may even be used to back the aircraft away from a terminal or dock. These propellers are generally coupled to the engine by a clutch mechanism and incorporate a brake so that the propeller may be both uncoupled from the engine during an engine shut-down and braked to a stop to prevent wind-milling, or free rotation.

Mechanics performing service or maintenance on this type of propeller must be able to remove, install, check operation, disassemble, and assemble them in accordance with manufacturer's and/or FAA specifications. Balancing and overhauling of this propeller assembly is accomplished in airline propeller shops or certificated propeller repair stations; however, the mechanic is required to diagnose propeller problems.

PRINCIPAL FINDINGS

N - Less than 10 percent of the mechanics in any industry category perform these tasks. Less than 2 percent of the airline overhaul mechanics work on this type of propeller.

F - Relatively few mechanics in any category indicate that they work at a high rate of frequency, with the exception of small general aviation, whose mechanics generally perform these tasks at a low rate of frequency.

I - In-depth industry training is provided to the airline overhaul mechanics and mechanics employed by the large general aviation companies.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

Except for the subtopics titled "Overhaul propeller" and "Check and service turboprop engine brake," all subtopics should be included in the aviation mechanics core curriculum. The identified subtopics were recommended for deletion on the basis of task specialization and training provided by industry.

TABLE 35. GOVERNORS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
LINE INSPECTION AND ADJUSTMENTS	$		+	+	H	H	H	H	3	4	3	3	3	4	3	3	3	4	3	3
APPLY THEORY OF OPERATION	-		+	+	H	H	H	H	3	4	3	3	3	3	3	3	3	4	4	3
SERVICE SYNCHRONIZATION SYSTEM	-		+	+	H	H	H	H	3	4	3	3	3	3	3	3	4	4	3	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			-	+		H	H	L		3	3	3		2	3	3		3	3	3
CHECK AND SERVICE BLEED VALVE GOVERNOR	$		$	$	H	H	H	H	1	4	3	3	3	3	3	3	3	4	4	1
BENCH TEST			-	$		H	H	H		3	4	3		3	3	3		3	3	3
OVERHAUL GOVERNOR			-	$		H	H	L		3	3	3		2	3	3		3	4	3

TABLE 35

GOVERNORS

OVERVIEW OF GOVERNORS AND WORK PERFORMED

Basically, governors are speed-sensing devices used in aircraft turbine and reciprocating engines. In turbine engines, governors prevent "over-speeding" of an engine during acceleration and "under-speeding" of the engine during deceleration; also a governor is used in some engines to bleed air from the compressor at a particular engine speed during acceleration in order to skirt a compressor "stall" zone. In reciprocating engines, governors are used to maintain a constant engine speed by increasing or decreasing the pitch of the propeller.

On reciprocating engines, mechanics make limited field adjustments on governors; however, on turbine engines the governors are pre-set by bench testing and are usually not field adjustable. Overhaul or repair shops have the proper test equipment to perform this specialized service. Mechanics perform checks and troubleshoot governor operation, remove, install, and properly rig governors where necessary.

PRINCIPAL FINDINGS

N - Less than 10 percent of the airline mechanics perform the tasks associated with governors.

F - Mechanics in all industrial categories generally work with governors at a high frequency; however, airline line station mechanics do not disassemble, assemble, bench test, or overhaul governors.

T - The technical knowledge required by airline overhaul stations is primarily at the analysis level, and large general aviation companies have the same requirement for mechanics who bench test governors.

M - The manipulative skill generally needed by mechanics performing these tasks allows reasonable time, but job planning is required.

I - Airline overhaul stations and large general aviation companies provide training in depth in many of the subtopics.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended deleting the subtopic identified as "Overhaul governor." All other subtopics should be included in the aviation mechanics core curriculum. The recommendation for deletion of the subtopic was based on the very limited number of mechanics who perform this task and the highly specialized equipment required to accomplish this training.

TABLE 36. DRAFTING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
USE AND INTERPRET STANDARD BLUEPRINT INFORMATION	+	+	+	+	H	H	H	H	2	3	3	3	2	3	1	3	3	4	1	1
CARE OF BLUEPRINTS	+	+	+	+	H	H	H	H	3	3	1	3	2	3	1	3	3	3	1	1
INTERPRET AND APPLY DATA IN TITLE BLOCK, BILL OF MATERIALS, ETC.	+		+	+	H	H	H	L	2	4	2	3	2	3	1	3	3	1	1	3
DRAW SHOP SKETCHES	$	-	+	+	H	H	H	H	2	3	3	3	2	3	3	3	3	3	3	1
USE APPROPRIATE SYMBOLS I.E., HYDRAULIC, ELECTRICAL, ETC.			+	+	H	H	H	H	3	1	3	3	4	2	3	2	1	3	3	2
USE AND CARE OF ESSENTIAL DRAFTING INSTRUMENTS AND EQUIPMENT			$	+	L	H	H	L	2	3	3	3	4	3	2	3	1	1	3	3
DRAW PROJECTIONS			$	+	H	H	H	L	3	3	3	3	3	3	3	3	1	3	3	1
USE OF SPECIFICATIONS AND DRAFTING ROOM MANUALS			$	+	H	H	H	L	3	3	3	3	3	2	3	3	2	4	3	1
DRAW INTERSECTIONS AND DEVELOPMENTS			$	+	H	H	H	L	3	3	3	3	3	3	3	3	1	3	3	3
DRAW LINES, DIMENSIONS, SECTIONS, SCALES, ETC.			$	+	H	H	H	L	3	3	3	3	3	2	2	3	1	3	3	3
DRAW TECHNICAL WORKING DRAWINGS			$	+	H	H	H	L	3	3	3	3	5	3	3	3	4	1	3	1

TABLE 36

DRAFTING

OVERVIEW OF WORK PERFORMED

Mechanics frequently work with blueprints and drawings when making installations and modification to the structure and systems of the airplane. They must be able to read and interpret data from schematics when analyzing system malfunctions and incorporate changes in drawings in accordance with standard drafting procedures. In addition, they often sketch small parts and develop shop drawings for replacement parts and repairs.

PRINCIPAL FINDINGS

N - There is evidence that mechanics in all industrial categories must be able to interpret standard blueprint information, be capable of caring for the blueprints, and have some skill in drawing shop sketches. Less than 2 percent of the airline mechanics actually draw projections or do similar formal drafting work.

F - Mechanics employed by small general aviation companies indicate that they infrequently use drafting equipment, draw projections, or prepare working drawings.

I - The relatively few airline mechanics who prepare drawings receive in-depth industry training.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

Based upon the findings, the committee recommended deleting the following subtopics:

1) Use of specification and drafting room manuals
2) Draw intersections and developments
3) Draw lines, dimensions, sections, scales, etc.
4) Draw technical working drawings

All other subtopics should be included in the aviation mechanics core curriculum.

TABLE 37. WEIGHT AND BALANCE

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
USE SPECIFICATIONS, DATA SHEETS, AND AIRCRAFT LISTING			+	+	L	L	H	H	1	4	3	3	4	4	3	3	3	2	3	3
PREPARE AND WEIGH AIRCRAFT			+	+	L	L	H	L	1	4	3	3	4	4	3	3	3	2	3	3
MEASURE MOMENT ARM			+	+	H	L	H	H	3	4	3	3	3	4	3	3	1	2	3	3
COMPUTE WEIGHT AND BALANCE			+	+	H	L	H	H	3	4	3	3	3	4	3	3	3	2	3	3
CORRECT FOR ADVERSE CONDITIONS OR EFFECTS OF IMPROPER LOADING			+	+	H	L	H	L	4	4	3	3	5	4	3	3	4	2	3	3
RECORD WEIGHT AND BALANCE DATA			+	+	L	L	H	H	1	4	3	3	4	4	3	3	3	2	3	3
USE TERMINOLOGY AND SYMBOLS			+	+	L	L	H	H	1	4	3	3	4	4	3	3	2	2	3	1
USE LOADING GRAPHS, CENTER OF GRAVITY ENVELOPES AND LOADING SCHEDULES			+	+	H	H	H	H	4	4	3	3	3	4	3	3	4	4	3	3
USE OF FAA 337 FORM AND CAM 18			+	+	L	H	H	H	3	4	3	3	3	4	3	3	2	1	3	3

TABLE 37

WEIGHT AND BALANCE

OVERVIEW OF WORK PERFORMED

Flight characteristics are significantly dependent upon an aircraft's weight and balance. The weight and balance of an aircraft is affected by the location and weight of installed equipment. Changes in weight and location of equipment affect (aircraft) balance. When the mechanic actually installs equipment or changes its location, he must know how to compute weight and balance and maintain the center of gravity within the manufacturer's specifications. Airplanes are weighed, and the center of gravity may be computed many times during the life of an airplane.

PRINCIPAL FINDINGS

N - Less than 2 percent of the mechanics employed by the airlines and more than 10 percent of the mechanics employed in general aviation perform weight and balance calculations.

F - General aviation mechanics perform weight and balance computation at a generally high level of frequency.

T - Technical knowledge required ranges from the knowledge level for airline line mechanics through the analysis level for airline overhaul mechanics.

I - The airlines offer in-depth training in the subtopics titled "Correct for adverse conditions or effects of improper loading" and "Use loading graphs, center of gravity envelopes, and loading schedules."

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended deleting the following subtopics:

1) Use loading graphs, center of gravity envelopes and loading schedules. Deletion recommended on the basis of task specialization and industry training offered.

2) Use of FAA 337 form and CAM 18. Deletion recommended on the basis of non-applicability.

All other subtopics identified by this table should be included in the aviation mechanics core curriculum.

TABLE 38. AIRCRAFT MATERIAL AND PROCESSES

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY STANDARD HARDWARE AND MATERIALS	+	+	+	+	H	H	H	H	3	3	2	3	2	3	1	3	3	3	3	3
USE THE TECHNICAL TERMINOLOGY COMMON TO MATERIALS UTILIZED IN AIRFRAMES AND PROPULSION UNITS	$	+	+	+	H	H	H	H	3	3	2	3	1	3	1	3	3	4	4	1
DEVELOP AN UNDERSTANDING OF STRUCTURE AND COMPOSITION OF METALS AND THEIR ALLOYS SUCH AS SAE STEELS, CORROSION RESISTANT STEEL, COPPER, NICKEL, ALUMINUM, MAGNESIUM, TITANIUM, SPECIAL HIGH TEMPERATURE METALS, ETC.	$	+	+	+	H	H	H	H	3	3	3	3	3	3	1	3	3	4	3	1
IDENTIFY TYPES OF CORROSION AND PREVENTIVE MEASURES	$	+	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3
IDENTIFY PIPING COLOR CODING	$	+	+	+	H	H	H	H	1	3	3	3	1	3	1	2	2	3	2	3
PERFORM BASIC HEAT TREATING AND ANNEALING PROCESSES	-	+	$	+	H	H	H	H	2	3	3	3	2	3	3	3	3	3	4	1
IDENTIFY PHYSICAL PROPERTIES OF MATERIALS	-	$	+	+	H	H	H	H	3	3	3	3	3	3	1	3	3	3	3	1
IDENTIFY MECHANICAL PROPERTIES OF MATERIALS	-	$	+	+	H	H	H	H	3	3	3	3	3	3	1	3	3	3	3	1
APPLY PRINCIPLES OF ADHESIVE BONDING	$	-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3
UTILIZE BASIC ECONOMIC AND ENGINEERING CRITERIA IN SELECTION OF MATERIALS	-		+	+	H	H	H	H	2	2	3	3	2	2	3	3	2	4	3	1
IDENTIFY WINDSHIELD AND WINDOW MATERIALS	-		+	+	H	H	H	H	1	3	3	3	2	3	3	3	3	3	3	3
USE HIGH ENERGY FORMING PROCESSES				-	H		H	H	3		3	3	3		3	3	3		4	3

TABLE 38

AIRCRAFT MATERIAL AND PROCESSES

OVERVIEW OF WORK PERFORMED

A mechanic's ability to properly inspect, repair, and maintain an airplane often depends upon his understanding of the basic processes and materials employed in its construction. Knowledge of the various materials, technical terminology, and the ability to identify standard hardware is essential to the aviation mechanic.

PRINCIPAL FINDINGS

F - Mechanics in all industrial categories indicated a high frequency for these tasks.

I - Airline overhaul mechanics receive in-depth training in the use of technical terminology, structure and composition of metals, and the identification and prevention of corrosion. Mechanics employed by large general aviation companies indicate that they are trained in the use of technical terminology, basic heat-treating and annealing processes, and the use of high energy forming processes.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended that all subtopics be included in the aviation mechanics core curriculum. The committee observed that many of these tasks and understandings are basic and therefore necessary to the mechanic's overall knowledge of the airplane and its systems.

TABLE 39. INSPECTION FUNDAMENTALS

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INSPECT FOR GENERAL SOURCE OF WEAR AND DETERIORATION	+	+	+	+	H	H	H	H	3	3	3	3	3	3	1	3	3	3	3	3
COMPLETE TYPICAL REPORT FORMS AND STATUS TAGS	+	+	+	+	H	H	H	H	1	3	3	3	1	3	1	2	2	3	3	1
USE PRECISION MEASURING DEVICES—MICROMETERS, HEIGHT GAGES, ETC.	+	$	+	+	H	H	H	H	3	3	3	3	3	1	2	3	2	3	2	3
USE MANUFACTURER'S INSPECTION DATA	$		+	+	H	H	H	H	3	1	2	3	3	2	1	3	2	4	2	1
USE NON-DESTRUCTIVE TESTING																				
PENETRANTS	-	-	+	+	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3
USE FUNDAMENTALS OF STATISTICAL INSPECTION	-		+	+	H	H	H	H	3	3	3	3	3	2	1	3	3	3	3	1
USE NON-DESTRUCTIVE TESTING																				
MAGNETIC PARTICLE	-		+	+	H	H	H	H	3	3	3	3	3	2	3	3	3	3	3	3
CHEMICAL ETCHING			$	+	H	H	H	L	4	3	3	3	3	2	3	3	3	3	3	3
HARDNESS	-		$	$	H	H	H	L	3	3	3	3	3	2	2	3	3	4	2	3
USE DESTRUCTIVE TESTING																				
TENSION			-	-			H	H			3	3			3	3			3	3
BENDING			-	-			H	H			3	3			3	3			3	3
IMPACT			-				H	H			3	3			2	3			3	3
USE NON-DESTRUCTIVE TESTING																				
ULTRA SONIC			-		H	H	H	H	3	3	2	3	3	3	3	3	3	4	2	3
RADIOGRAPHY (X RAY)					H	H	H	H	3	4	3	3	3	4	3	3	3	3	2	1

TABLE 39

INSPECTION FUNDAMENTALS

OVERVIEW OF WORK PERFORMED

Mechanics inspect both materials and components to determine condition, wear, material strength, and fatigue. Many inspection techniques and devices are used, such as micrometers, gauges, and X ray. Non-destructive methods are used in the inspection and maintenance of airplanes and their components, while destructive testing is most generally used during the manufacturing process.

PRINCIPAL FINDINGS

N - Less than 5 percent of the mechanics use destructive testing as a means of inspection and none perform this task in the airline industry.

F - Most of the subtopic tasks are performed at a high rate of frequency by mechanics in all categories.

I - Airline overhaul mechanics indicate that they receive in-depth training in the use of manufacturer's inspection data, hardness testing, and the techniques of ultrasonic inspection.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended deleting the subtopic, "Use destructive testing: tension, bending, and impact." They further recommended that the use of eddy current non-destructive testing be included in the aviation mechanics core curriculum. This subtopic has been added to the core curriculum and is listed on page 191.

TABLE 40. AIRCRAFT AND ENGINE INSPECTION

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
PERFORM AND RECORD INSPECTIONS PER MANUFACTURER'S FAA OR PROGRESSIVE REQUIREMENTS	+	-	+	+	H	H	H	H	3	3	3	3	3	2	3	3	3	4	3	3
INSPECT AIRCRAFT (WALK AROUND)	+	-	+	+	H	H	H	H	3	2	3	3	3	4	1	3	3	3	3	3
USE INSPECTION GUIDES	+	-	+	+	H	H	H	H	3	2	3	3	3	1	1	3	3	2	1	3
INSPECT AIRCRAFT (ANNUAL)	+		+	+	H	H	H	H	3	3	3	3	3	4	1	3	3	3	3	3
USE MANUFACTURER'S SERVICE BULLETINS	$	$	+	+	H	H	H	H	3	3	3	3	3	1	1	3	3	2	3	3
INSPECT AIRCRAFT (OVERHAUL CHECKS)	$		+	+	H	H	H	H	3	4	3	3	3	5	1	3	3	4	3	3
USE GENERAL AVIATION INSPECTION AIDS SUMMARY	-		+	+	H		H	H	3		3	3	3		1	3	4		1	3
CHECK STORAGE STATUS OF NON-ACTIVE AIRCRAFT			+	+	H	H	H	H	3	1	3	3	3	1	3	3	4	2	3	3

TABLE 40

AIRCRAFT AND ENGINE INSPECTION

OVERVIEW OF WORK PERFORMED

Aircraft and engine inspections may range from pre-flight checks to the detailed inspection following a major overhaul. Mechanics must know how to determine the condition of the aircraft and powerplant, how to use inspection guides, and how to properly record the inspection on the required forms.

PRINCIPAL FINDINGS

N - More than 10 percent of the mechanics in general aviation perform aircraft and engine inspections.

F - All mechanics perform inspections at a high frequency.

T - The technical knowledge required by airline overhaul mechanics is at the analysis level when they are accomplishing aircraft overhaul checks.

M - Airline overhaul mechanics indicate that time is critical and that they must do job planning as they perform "walk around" and annual inspections and inspect the aircraft during overhaul checks.

I - The airlines provide training in-depth for several of the subtopics, while general aviation training is primarily basic or informational.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended that "Checking the storage status of nonactive aircraft" be deleted from the curriculum. All other subtopics should be included in the aviation mechanics core curriculum.

TABLE 41. GROUND SUPPORT EQUIPMENT

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
USE HYDRAULIC EQUIPMENT	+	−	+	+	H	H	H	H	2	3	2	3	3	5	2	3	3	4	2	3
USE PNEUMATIC EQUIPMENT	+	−	+	+	H	H	H	H	2	3	2	3	3	5	2	3	3	3	2	3
USE ELECTRICAL EQUIPMENT	+	−	+	+	H	H	H	H	2	3	3	3	3	5	2	3	3	4	2	3
USE FUELS, LUBRICANTS AND FLUIDS	+	−	+	+	H	H	H	H	2	3	2	3	3	5	2	3	3	4	2	3
USE GROUND FIRE PROTECTION	+	−	+	+	H	H	H	H	2	3	3	3	3	4	2	3	3	4	2	3
USE LINE STARTING EQUIPMENT	+	−	+	+	H	H	H	H	2	3	2	3	3	3	2	3	3	4	2	1
DRIVE FUEL TRUCKS	$		+	+	H	H	H	H	2	4	3	3	3	4	3	2	3	4	3	3
USE GROUND AIR CONDITIONER	$		+	$	H		H	H	2		3	3	3		2	3	2		3	3

TABLE 41

GROUND SUPPORT EQUIPMENT

OVERVIEW OF WORK PERFORMED

Mechanics operate and supervise the use of ground power units, air conditioners, and fueling and fire protection equipment. They must also know how to service and maintain such equipment.

PRINCIPAL FINDINGS

N - Less than 5 percent of the airline overhaul mechanics accomplish the tasks identified in this table.

F - Mechanics in all industrial categories indicated that they performed these tasks frequently.

M - The very few airline overhaul mechanics who use ground support equipment must do job planning and accomplish the work under critical time limitations.

I - Airline overhaul stations provide training in depth as a specialty, rather than the general knowledge approach in the other industrial categories.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended that the ability and the associated knowledge required to drive fuel trucks and operate ground air conditioners are not to be included in the aviation mechanics core curriculum; therefore, the subtopics "Drive fuel trucks" and "Use ground air conditioner" have been deleted from the core curriculum. All other subtopics are included.

TABLE 42. GROUND HANDLING

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
USE STANDARD LINE AND TAXI SIGNALS	+	-	+	+	H	H	H	H	2	3	2	3	2	4	5	1	3	4	4	1
USE TOW BARS AND TOWING EQUIPMENT	+	-	+	+	H	H	H	H	2	3	3	3	3	1	2	3	3	4	3	1
JACK AIRCRAFT	+	-	+	+	H	H	H	H	3	3	3	3	3	1	3	3	3	4	3	3
SPOT AND MOOR AIRCRAFT	$	-	+	+	H	H	H	H	4	3	3	3	3	1	3	3	3	4	3	1
FUEL AIRCRAFT	$	-	+	+	H	H	H	H	2	3	3	3	2	5	3	2	4	4	3	1
PERFORM PRE-FLIGHT SERVICING	$	-	+	+	H	H	H	H	3	3	3	3	3	5	2	2	3	4	2	3
PERFORM POST-FLIGHT SERVICING	$	-	+	+	H	H	H	H	3	3	3	3	3	5	2	2	3	4	2	3
TAXI AIRCRAFT	-	-	+	+	H	H	H	H	3	3	3	3	3	1	3	3	4	4	3	1
HOIST AIRCRAFT			+	+	H	H	H	H	4	4	3	3	5	4	3	3	3	4	3	3

TABLE 42

GROUND HANDLING

OVERVIEW OF WORK PERFORMED

Mechanics taxi, tow, and position airplanes on the ground. They also direct aircraft on the ground through the use of hand signals. Mechanics must know how to jack and hoist the aircraft, as well as secure it for adverse weather conditions.

PRINCIPAL FINDINGS

N - Less than 5 percent of airline overhaul mechanics perform the tasks identified in this table.

F - Mechanics in all of the industrial categories indicated that they perform ground handling jobs frequently.

T - Airline mechanics indicate that their knowledge of methods of hoisting an airplane is at the analysis level.

M - Airline mechanics hoist aircraft under time critical conditions.

I - The limited number of airline overhaul mechanics who do this work are trained in depth in all of the subtopics. Mechanics at airline line stations receive in-depth training in fueling and taxiing aircraft.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended deleting the subtopic titled "Hoist aircraft" because this is a specialized task occurring infrequently and utilizing special equipment. All other subtopics should be included in the aviation mechanics core curriculum.

TABLE 43. CLEANING AND CORROSION CONTROL

	N				F				T				M				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
IDENTIFY APPLICATIONS AND LIMITATIONS OF																				
CHEMICAL SOLVENTS AND PAINT REMOVERS	-	+	+	+	H	H	H	H	4	3	3	3	3	3	2	3	3	3	3	3
USE CLEANING EQUIPMENT AND PROCEDURES FOR																				
VAPOR DEGREASING	$	-	+	+	H	H	H	H	2	3	3	3	3	3	3	3	3	3	3	3
INSPECT FOR EVIDENCE OF CORROSION IN CRITICAL AREAS	$	-	+	+	H	H	H	H	3	3	3	3	3	3	2	3	3	3	3	3
IDENTIFY APPLICATIONS AND LIMITATIONS OF																				
SOAPS AND DETERGENTS	$		+	+	H	H	H	H	4	1	2	3	3	2	2	2	3	3	3	3
WINDOW AND WINDSHIELD CLEANING AGENTS	$		+	+	H	H	H	H	1	3	2	3	2	3	2	3	3	3	3	3
INSPECT AND DETERMINE ADEQUACY OF CLEANING PERFORMED ON AIRPLANES	$		+	+	H	H	H	H	3	3	3	3	3	3	2	2	3	3	3	1
APPLY PRINCIPLES OF AIRPLANE CLEANING AND CORROSION CONTROL	-	-	+	+	H	H	H	H	4	1	3	3	3	2	2	3	3	3	1	3
USE INTERIOR CLEANING EQUIPMENT AND PROCEDURES	-		+	+	H	H	H	H	3	1	2	3	5	2	2	3	3	3	1	3
USE CARBON REMOVERS	-		+	+	H	H	H	H	3	1	3	3	3	2	2	3	2	3	3	3
USE SAND, SHELL, GRIT, AND VAPOR BLASTING			+	+	H	H	H	H	3	3	3	3	3	1	2	3	3	3	1	3
USE CLEANING EQUIPMENT AND PROCEDURES FOR																				
ELECTRICAL COMPONENT CLEANING	-		$	+	H	H	H	H	3	4	3	3	3	4	3	3	3	2	3	3
ULTRASONIC DEGREASING			-	-	H	H	H	H	3	3	3	3	3	1	3	3	3	3	2	1

TABLE 43

CLEANING AND CORROSION CONTROL

OVERVIEW OF WORK PERFORMED

Mechanics clean the airplane, both inside and out, to prevent and control corrosion. The improper use of a solvent or cleaning agent can do more damage than the material that was removed. Improper neutralization of spilled battery acid and other chemicals can cause severe structural damage. A thorough cleaning is necessary in order to properly inspect an aircraft.

PRINCIPAL FINDINGS

F - Mechanics in all industrial categories perform cleaning and corrosion control frequently.

T - Airline line mechanics require analysis levels of technical knowledge for subtopics pertaining to cleaning and corrosion control.

M - Airline line mechanics work under critical time conditions when cleaning the interiors of airplanes.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

The committee recommended that the subtopic "Identify the applications and limitations of chemical solvents and paint removers" include information relative to the flammability and explosive characteristics of these materials; therefore, this subtopic has been expanded to include flammability and explosive characteristics of these materials. All subtopics should be included in the aviation mechanics core curriculum.

TABLE 44. MATHEMATICS

	N				F				T				A/S				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
ADD, SUBTRACT, MULTIPLY AND DIVIDE	+	+	+	+	H	H	H	H	3	3	3	3	1	1	1	1	3	1	1	1
READ AND INTERPRET GRAPHS AND CHARTS	+	–	+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	3	4	1
CALCULATE RATIOS, PROPORTIONS AND PERCENTAGES	+		+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1
PERFORM ALGEBRAIC OPERATIONS INVOLVING SUBTRACTION, ADDITION, MULTIPLICATION AND DIVISION OF POSITIVE AND NEGATIVE NUMBERS	$		+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	3	1	1
PERFORM LAYOUTS UTILIZING FUNDAMENTALS OF GEOMETRIC CONSTRUCTION	–		+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	2	1	1
EXTRACT ROOTS AND RAISE NUMBERS TO GIVEN POWERS	$		$	+	H	H	H	H	3	4	3	3	1	1	1	1	1	1	1	1
PERFORM DESCRIPTIVE GEOMETRY AS APPLIED TO TEMPLATE DEVELOPMENT AND LAYOUT	–	–	$	+	H	H	H	L	3	3	3	3	1	1	1	1	1	1	1	1
CALCULATE AREAS AND VOLUMES OF VARIOUS GEOMETRIC SHAPES	–		$	+	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1
PERFORM CALCULATIONS COMMON TO RIGHT TRIANGLES AND USE OF TRIGONOMETRIC TABLES	–		$	+	H	H	H	H	3	1	3	3	1	1	1	1	1	1	1	1
PERFORM CALCULATIONS INVOLVING USE OF SLIDE RULE	–		–	+	H	H	H	H	3	2	3	3	1	1	1	1	1	1	1	1

TABLE 44

MATHEMATICS

OVERVIEW OF WORK PERFORMED

Mathematics is a basic requirement for the aviation mechanic, even though requirements will vary with the type of work being performed. The skills may range from basic arithmetic through the algebra required for weight and balance computation to the geometry and trigonometry required for template development and layout. Electrical and electronic circuit analysis may require the use of advanced mathematics. Many formulas are available to the mechanics who require solutions of problems in mathematics.

PRINCIPAL FINDINGS

F - Aviation mechanics in all industrial categories indicate that the use of mathematics is at a high frequency.

A/S- Accuracy of computation is emphasized.

I - Generally, no industry training is provided.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

Performing calculations common to a right triangle and the use of trigonometric tables and performing calculations involving the use of a slide rule are recommended for deletion from the aviation mechanics curriculum. The committee also recommended that the schools test to determine where remedial training is required. All other subtopics should be included in the core curriculum.

TABLE 45. ENGLISH

	N A O L S	F A O L S	T A O L S	A/S A O L S	I A O L S
READ, WRITE AND SPEAK THE ENGLISH LANGUAGE	+ + + +	H H H H	3 2 3 3	2 1 2 1	1 1 1 1
WRITE CLEAR, CONCISE, GRAMMATICALLY CORRECT TECHNICAL REPORTS NORMALLY EXPECTED OF CERTIFICATED MECHANICS	+ + + +	H H H H	3 3 2 3	2 1 2 1	1 1 1 1
USE DICTIONARY AND STANDARD REFERENCE BOOKS	+ + + +	H H H H	3 3 2 3	1 1 2 1	1 1 1 1
READ PERTINENT TECHNICAL DATA WITH COMPREHENSION	+ + + +	H H H H	3 3 2 3	1 1 2 1	1 1 1 1

TABLE 45

ENGLISH

OVERVIEW OF WORK PERFORMED

The ability to speak, read, write, and understand the English language is required of the aviation mechanic. He must communicate with others, and write descriptions of technical work performed when he makes the required entries in the aircraft maintenance records. Reading comprehension is necessary if the mechanic is to understand maintenance manuals and other publications related to servicing, inspection, and repair of the aircraft.

PRINCIPAL FINDINGS

N,F- More than 10 percent of the mechanics in all industrial categories utilize the subtopics at a high rate of frequency during performance of their jobs.

A/S- Mechanics employed by large general aviation companies indicated that both speed and accuracy are required.

I - No industry training is provided.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum. The committee strongly recommended that increased emphasis be placed on the teaching of English and the schools should initiate remedial training as required. The committee repeatedly stressed that the aviation mechanic who is to succeed in the aviation industry must be able to use the English language correctly and that schools should assist in every way to reinforce his ability to use the language.

TABLE 46. PHYSICS

	N				F				T				A/S				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
PERFORM CALCULATIONS INVOLVING MECHANICS SUCH AS LEVERS, PULLEYS, INCLINED PLANES, LINEAR MOTION, ETC.	+	+	+	+	H	H	H	H	3	1	3	3	1	1	1	1	1	1	1	1
SOLVE GAS AND FLUID PROBLEMS SUCH AS PRESSURE, VOLUME, PASCAL'S LAW, BERNOULLI'S PRINCIPLE, ETC.	-		+	+	H	H	H	H	3	3	3	3	1	1	2	1	1	3	4	1
PERFORM TEMPERATURE CONVERSIONS, PROBLEMS INVOLVING RELATIONSHIPS OF GASES AND PRESSURES AND MECHANICAL EQUIVALENTS OF HEAT	-		+	+	H	H	H	L	3	3	3	3	1	1	2	1	1	3	4	1
PERFORM NECESSARY CALCULATIONS TO UNDERSTAND EFFECT OF SPEED OF SOUND, FREQUENCY, PRESSURE, LOUDNESS, REFLECTION OF SOUND WAVES, ETC.			$	$	L	H	H	H	3	3	3	3	1	1	2	1	1	1	4	1

TABLE 46

PHYSICS

OVERVIEW OF WORK PERFORMED

An understanding of the laws of physics helps the mechanic to better understand the aircraft systems with which he must work. With such principles to guide him, he has a better foundation to analyze, troubleshoot, service, and maintain the various aircraft and powerplant systems.

PRINCIPAL FINDINGS

F - Generally, aviation mechanics apply the principles of physics at a high rate of frequency.

I - Mechanics employed by large general aviation companies indicate that they receive in-depth training in a majority of the subtopics. Otherwise very little industry training is generally offered.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 47. CHEMISTRY

	N				F				T				A/S				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
APPLY CHEMICAL PRINCIPLES TO																				
ELECTROLYSIS AND ITS EFFECT	$	-	+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	3	1	1
BASIC CHEMISTRY OF FUELS, LUBRICANTS AND HYDRAULIC FLUIDS	-	$	+	+	H	H	H	H	3	3	3	3	1	1	1	1	3	3	3	1
THE BASIC CHEMISTRY OF PAINTS, LACQUERS AND THINNERS	-	-	+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	3	3	1
THE CHEMICAL REACTIONS WITHIN BATTERIES	-		+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	2	3	1
THE CHEMISTRY OF ADHESIVES AND SEALING MATERIALS	-	-	$	+	H	H	H	H	2	3	3	3	1	1	1	1	2	3	3	1
COMMON ELEMENTS AND ELEMENTARY COMPOUNDS SUCH AS SALTS, BASES, AND ACIDS			$	+	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1
THE CHEMISTRY OF PLASTICS BOTH CLEAR AND REINFORCED	-		$	$	H	H	H	H	3	3	3	3	1	1	1	1	1	3	3	1
THE COMPOSITION OF MATTER—MOLECULES, ATOMS AND ELECTRONS	-		-	$	H		L	H	3		1	3	1		1	1	1		1	1
THE CHEMISTRY OF NATURAL AND SYNTHETIC FABRICS			-	$			H	L			3	3			1	1			3	1
USE CHEMICAL SYMBOLS AND EQUATIONS	-		-	-	H	H	H	H	3	3	3	3	1	1	1	1	1	1	3	1
USE PERIODIC TABLE				-		H	H	L		3	2	3		1	1	1		2	3	1

TABLE 47

CHEMISTRY

OVERVIEW OF WORK PERFORMED

A mechanic must be aware of certain chemical principles if he is to understand the operation and maintenance of batteries; the process of plating, the prevention of corrosion; and the properties of the various aircraft fluids, fuels, solvents, and paints. Although mechanics do not work with chemical formulas, they do make many practical applications of the principles of chemistry.

PRINCIPAL FINDINGS

N - Less than 10 percent of the airline mechanics indicated that they used the knowledge identified by the subtopics of this table.

F - Generally, mechanics in all industrial categories frequently apply chemical principles in the performance of their job.

A/S- All segments of industry indicate that there is a requirement for accuracy.

I - Very little industry training is given, although the principles of chemistry are included in various orientation, or basic, informational content courses.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

As a result of the findings, the committee recommended deleting the subtopics titled:

1) Apply chemical principles to the chemistry of plastics, both clear and reinforced

2) The composition of matter, molecules, atoms, and electrons

3) The chemistry of natural and synthetic fabrics

4) Use of chemical symbols and equations

5) Use of periodic table

All other subtopics should be included in the core curriculum.

TABLE 48. AIRCRAFT NOMENCLATURE

	N A O L S	F A O L S	T A O L S	A/S A O L S	I A O L S
USE PROPER AIRCRAFT NOMENCLATURE	+ + + +	H H H H	3 2 3 3	1 1 2 1	2 3 3 1
CLASSIFY AIRCRAFT AS TO PROPULSION DEVICES, WING ARRANGEMENT, PURPOSE, LANDING GEAR SYSTEMS, ETC.	+ - + +	H H H H	3 3 3 3	1 1 2 1	3 2 3 1
APPLY FAA AIRCRAFT CATEGORIES AND DEFINITIONS AS FOUND IN APPROPRIATE PUBLICATIONS SUCH AS FAR 1, 21, 23, ETC.	$ - + +	H H H H	3 1 3 3	1 1 2 1	1 3 3 1

TABLE 48

AIRCRAFT NOMENCLATURE

OVERVIEW OF WORK PERFORMED

Aviation mechanics must use proper nomenclature to communicate effectively. Mechanics order parts, prepare malfunction reports, make entries in maintenance records, and comply with service letters and Airworthiness Directives. Correct nomenclature is essential in writing or interpreting technical reports.

PRINCIPAL FINDINGS

F - Mechanics in all industrial categories use technical terms and nomenclature constantly.

I - Industry training ranges from no training to basic, informational content courses.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 49. THEORY OF FLIGHT

	N				F				T				A/S				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
INTERPRET THEORY OF FLIGHT IN RELATION TO																				
REFERENCE AXES OF AIRCRAFT	$	$	+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	3	3	1
FUNCTION OF CONVENTIONAL CONTROLS AND CONTROL SURFACES	$	$	+	+	H	H	H	H	4	1	3	3	1	1	1	1	1	3	3	1
HIGH LIFT DEVICES SUCH AS FLAPS, SLATS, ETC.	$	$	+	+	H	H	H	H	3	1	3	3	1	1	1	1	3	3	3	1
PROPERTIES OF THE EARTH'S ATMOSPHERE	$	-	+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1
AIRCRAFT MANEUVERS SUCH AS TURNS, SKIDS, STALLS, ETC.	$	-	+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	3	3	1
FORCES ACTING ON AN AIRFOIL AND AIRPLANE	$		+	+	H	H	H	H	3	3	3	3	1	1	1	1	1	2	1	1
UNCONVENTIONAL CONTROLS AND CONTROL SURFACES	$		+	+	H	H	H	H	3	3	3	3	1	1	1	1	3	3	3	1
LOADS AND EFFECT OF TURBULENCE AND SPEED	$		+	+	H	H	H	H	3	3	3	3	1	1	1	1	4	3	3	1
WING LOADING, POWER LOADING, MANEUVERING SPEED, ETC.	-		+	+	H	H	H	H	3	3	3	3	1	1	1	1	2	3	1	1
ROTARY WING	-		$	+	H	H	H	H	3	3	3	3	1	1	2	1	1	1	3	3
ROTORCRAFT FLIGHT CONTROLS AND THEIR EFFECTS	-		$	+	H	H	H	H	3	3	3	3	1	1	2	1	1	1	3	3
THRUST TORQUE AND TORQUE CORRECTION AS APPLIED TO ROTORCRAFT	-		$	+	H	H	H	H	3	3	3	3	1	1	2	1	1	4	4	1

TABLE 49

THEORY OF FLIGHT

OVERVIEW OF WORK PERFORMED

Mechanics must understand the relationships between the atmosphere and the airplane and its forces in flight in order to make intelligent decisions affecting the flight safety of both airplanes and helicopters. Understanding why the airplane is designed with a particular type of primary and secondary control system, and why the surfaces must be aerodynamically smooth become essential knowledge when maintaining today's complex aircraft.

PRINCIPAL FINDINGS

N - Less than 10 percent of the airline mechanics report that they make use of this knowledge.

F - Mechanics in all of the industrial categories indicate that they use theory of flight knowledge at a high rate of frequency.

I - Airline line mechanics indicate that they receive in-depth training in loads and the effect of turbulence and speed. General aviation companies specializing in rotorcraft provide basic or general information training for their mechanics, but training by fixed wing operators in theory of flight is generally not provided.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 50. FAR AND RELATED PUBLICATIONS

	N	F	T	A/S	I
	A O L S	A O L S	A O L S	A O L S	A O L S
USE SPECIFICATIONS, DATA SHEETS, MANUALS, AND PUBLICATIONS ON AIRCRAFT, ENGINES AND PROPELLERS	+ + + +	H H H H	3 2 3 3	1 1 2 1	3 3 3 1
USE REQUIRED FEDERAL AIR REGULATIONS	+ + + +	H H H H	3 3 3 3	1 1 1 1	3 4 3 1
INTERPRET AND USE SPECIFICATIONS SUCH AS MS, AC, AN, NAS AND TYPICAL MANUFACTURER'S MANUALS	+ + + +	H H H H	3 3 2 3	1 1 1 1	3 1 4 1
INTERPRET AND USE ATA SPECIFICATION 100	+ + + +	H H H H	2 3 3 3	1 1 1 1	3 1 3 1
USE FLIGHT SAFETY MECHANICS BULLETINS	+ + + +	H H H H	3 3 2 3	1 1 1 1	3 4 1 1
KNOW HOW AND WHERE TO FIND PERTINENT DATA IN FAA SPECIFICATIONS	+ + + +	H H H H	3 1 3 3	1 2 1 1	3 3 3 1
USE OF LOGBOOKS AND MAKING MAINTENANCE RECORD ENTRIES	+ – + +	H H H H	3 3 3 3	1 1 1 1	3 3 3 1
USE AND DISPOSITION OF FAA FORMS	– + + +	H H H H	3 3 3 3	1 1 2 1	3 3 3 1
USE AIRWORTHINESS DIRECTIVES (FAR 39)	– + + +	H H H H	3 2 3 3	1 1 1 1	3 3 3 1
FILE AND INDEX PUBLICATIONS	$ $ + +	H H H H	3 1 3 3	1 1 1 1	3 3 3 1
USE OF TECHNICAL STANDARD ORDERS (TSO) AND SUPPLEMENTAL TYPE CERTIFICATE (STC)	$ + +	L H H H	3 2 3 3	1 1 1 1	3 3 3 1

TABLE 50

FAR AND RELATED PUBLICATIONS

OVERVIEW OF WORK PERFORMED

Mechanics must be able to use FAA forms, Airworthiness Directives, logbooks, Technical Standard Orders, Federal Air Regulations, and Flight Safety Mechanics Bulletins. They must know where to find and how to apply such data in maintaining aircraft.

PRINCIPAL FINDINGS

F - All mechanics indicate that they use FAR and related publications, but airline line mechanics rarely use Technical Standard Orders.

A/S- General aviation mechanics must be accurate in the use of publications and FAA forms and be able to find this information rapidly.

I - The airlines provide depth training to their overhaul mechanics in the use of Federal Air Regulations and Flight Safety Mechanics Bulletins. Mechanics employed by large general aviation companies are trained to use and interpret manufacturer's manuals. Small general aviation companies do not provide training in FAR and related publications.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 51. SHOP MANAGEMENT RESPONSIBILITIES

	N				F				T				A/S				I			
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S
MAINTAIN REQUIRED RECORDS	+	+	+	+	H	H	H	H	3	3	3	3	1	1	1	1	3	3	3	1
APPLY FAA REGULATIONS IN REPAIR STATION OPERATION	$	+	+	+	H	H	H	H	3	3	3	3	1	1	1	1	3	1	3	3
APPLY SHOP MANAGEMENT PRINCIPLES TO ORGANIZATION AND ASSIGNMENT OF PERSONNEL	$	+	+	+	H	H	H	H	3	3	3	3	1	2	2	1	4	3	3	1
PURCHASE PARTS AND SUPPLIES	-	+	+	+	H	H	H	H	3	1	3	3	1	1	1	1	2	2	1	1
PERFORM ELEMENTARY ACCOUNTING	-	+	+	+	H	H	H	H	3	3	3	3	1	2	1	1	1	3	3	1
PERFORM INVENTORY CONTROL OF MATERIALS, EQUIPMENT	$	$	+	+	H	H	H	H	3	1	3	3	1	2	1	1	2	3	1	1
PERFORM JOB ESTIMATING	$	$	+	+	H	H	H	H	3	1	3	3	1	2	1	1	1	1	1	1

TABLE 51

SHOP MANAGEMENT RESPONSIBILITIES

OVERVIEW OF WORK PERFORMED

Mechanics should know the business principles and economics of operating an aircraft maintenance business. Such understanding helps promote work efficiency within an organization. Fundamentals of elementary accounting, job estimating, and inventory control must be a part of the mechanic's knowledge if he plans to work for himself or for a small aviation company.

PRINCIPAL FINDINGS

N - All industrial categories indicate that mechanics have shop management responsibilities.

F - All mechanics perform these tasks at a high rate of frequency.

T - The technical knowledge level for most subtopics is at the application level, although airline overhaul mechanics are not generally responsible for purchasing, inventory control, or job estimating.

I - Airline line mechanics receive in-depth management training with regard to organization and assignment of personnel.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

TABLE 52. ETHICS AND LEGAL RESPONSIBILITIES

	N				F				T					I			
	A	O	L	S	A	O	L	S	A	O	L	S		A	O	L	S
EMPLOY ETHICAL PRACTICES RELATED TO																	
JOB AND PRODUCT PRIDE AND CRAFTSMANSHIP	+	+	+	+	H	H	H	H	5	5	5	5		2	3	3	1
MECHANIC-EMPLOYER RELATIONSHIP	+	+	+	+	H	H	H	H	5	5	5	5		3	3	3	1
THE RESPONSIBILITIES OF AVIATION	+	+	+	+	H	H	H	H	5	5	5	5		3	3	3	1
PERSONAL CONDUCT AND INTEGRITY	+	+	+	+	H	H	H	H	5	5	5	5		3	3	3	1
PRACTICE THE LEGAL RESPONSIBILITIES OF																	
LIABILITY OF THE CERTIFICATED MECHANIC	+	+	+	+	H	H	H	H	5	5	5	5		3	3	3	1
EMPLOY ETHICAL PRACTICES RELATED TO																	
MECHANIC-CUSTOMER RELATIONSHIP	+		+	+	H	H	H	H	5	5	5	5		2	3	3	1
PRACTICE THE LEGAL RESPONSIBILITIES OF																	
BAILMENT			+	+		H	H	H		5	5	5			4	3	1
MECHANICS LIENS			+	+		H	H	H		5	5	5			4	3	1

TABLE 52

ETHICS AND LEGAL RESPONSIBILITIES

OVERVIEW OF WORK PERFORMED

Mechanic-customer relations are important to the success of a business. Good labor-management relationships contribute to the mechanic's advancement and financial security. Good personal conduct and unquestionable integrity are as important for the mechanic as for any individual. Mechanics must be technically competent, have pride of craftsmanship, and be dedicated to safety in aviation. The individual mechanic must also be aware of his legal liabilities and responsibilities.

PRINCIPAL FINDINGS

N - All industrial categories indicate that the mechanic must be constantly aware of his ethical and legal responsibilities.

T - All industry indicates that pride of craftsmanship, personal conduct, integrity, liability, and the responsibility of the certificated mechanic must be at the synthesis level.

I - Although airline line mechanics indicate that they have no need for the knowledge implied by the subtopics "bailment" and "mechanics liens," a select group of airline overhaul mechanics are given in-depth training in these two subtopics.

NATIONAL ADVISORY COMMITTEE RECOMMENDATIONS

All subtopics should be included in the aviation mechanics core curriculum.

DISCUSSION OF FINDINGS

A review of the data received from the aviation industry during the survey suggests that certain trends are developing. In addition, some of the findings reinforced some opinions expressed in aviation circles, while other findings reveal that certain opinions cannot be substantiated or are no longer applicable to the aviation industry. A compilation of these trends follows.

1) There is a common core of tasks performed by all aviation mechanics requiring the same technical knowledge levels.

The National Advisory Committee parameters applied to the survey data showed that all aviation mechanics performed to the same technical knowledge levels in 63 percent of the subtopics. Another 10 percent of the subtopics were found to be performed to identical technical knowledge levels by mechanics in three of the four industrial categories. The total common technical knowledge levels involve 73 percent of the subtopics. This high percent of the commonality of tasks performed by aviation mechanics in the four industrial categories strongly supports the premise that aviation mechanics can be trained through a core curriculum and can specialize in the latter part of their training for the industrial category in which they may seek employment.

2) The predominant technical knowledge level at which the aviation mechanic works is the application level or higher.

When all the subtopics had been analyzed, 86 percent were found to have been rated by mechanics in at least three of the industrial categories as requiring technical knowledge at the application, or a higher, level. Mechanics indicated they can accomplish the remaining 14 percent of the subtopics with either the knowledge and/or comprehension level of technical knowledge, which require the ability to follow directions and/or to locate and interpret information. These findings substantiate the need to train aviation mechanics to the application level so that transfer of learning to industry is easily accomplished.

3) Many airline overhaul mechanics are specialists in the particular area of work for which they receive extensive training.

With the exclusion of the subtopics in Tables 44-52, it is found that the airline overhaul mechanic performs 393 of the 437 subtopics in the remaining tables. Of these, 364 tasks were performed by less than 5 percent of the mechanics for each of the subtopics. These specialized mechanics received in-depth training for 54 percent of these subtopics, basic or general information training for 43 percent, and orientation or no training for the remaining 3 percent.

4) There is an increasing use of turbine engines in general aviation.

During the period of one year that elapsed between the California survey and the national survey, the percent of general aviation mechanics performing overhaul work on turbine engines increased from "No mechanics" among those surveyed in 1965 to 5 percent of those surveyed in 1966. Following examination of the responses for the 507 subtopics by small general aviation, it was noted that training in depth was provided for only 10 tasks. Seven of these, however, were in subtopics associated with turbine engines. The influx of turbine engines into general aviation suggests the need for in-depth training for those currently employed. This need for well-trained turbine mechanics should be reflected in the school curriculum.

5) The majority of airline mechanics no longer work on reciprocating engines having less than 14 cylinders.

No airline mechanics responded to any task required for maintenance or overhaul of a reciprocating engine of less than 14 cylinders. This finding is particularly significant in view of the fact that the results of this survey represent tasks performed by 15,258 airline mechanics. General aviation mechanics, however, are deeply involved in checking, servicing, repairing, and overhauling four- or six-cylinder opposed engines and seven- or nine-cylinder radial engines.

6) Fixed pitch wood propellers and ground adjustable propellers no longer appear in airline operation. Their number is decreasing in general aviation.

According to the survey data, airline mechanics do not work on fixed pitch wood propellers or ground adjustable propellers. The work that is most frequently accomplished in general aviation on ground adjustable propellers involves minor repairs to the blade and hub. Large general aviation companies frequently remove and install these propellers but all other subtopics in large and small general aviation are performed at a low frequency.

7) Electricity and electronics are becoming integrated into the airframe and powerplant mechanic's occupation.

The mechanics in the airline industry and in large general aviation companies performed all 28 tasks surveyed in the areas of electricity and electronics at a high frequency. Mechanics in small general aviation also performed all tasks at a high frequency, with the exception of checking and troubleshooting solid state switching devices. All indications point to the necessity for the schools to increase the emphasis in the instruction of electricity and electronics in the aviation mechanics' courses.

8) The maintenance of flight instruments, automatic flight and approach control systems, and aircraft communications and navigation equipment is extremely specialized work.

The airline industry generally provides training in depth for mechanics doing maintenance work on flight instruments, automatic approach control systems and communications, and navigation systems. Mechanics in large general aviation receive training in depth in maintenance of auto pilots and approach control systems and application training in all other related areas. Mechanics in small general aviation receive basic and general information training in the basic flight instruments but generally receive no industry training in any other related areas. Specially certificated mechanics and specialized shops frequently repair these systems. The National Advisory Committee has recommended that schools teach to the comprehension level in these specialties.

9) The need for mechanics skilled in woodworking has decreased substantially in the aviation industry.

The survey found that the airline industry no longer requires mechanics to be skilled in woodworking. Few highly specialized airline overhaul mechanics perform wood repairs to interior cabinets and paneling. Large general aviation companies assign these tasks to a few mechanics who perform these tasks at a low frequency. Of 2,463 large general aviation mechanics surveyed, only 174, or 7 percent, indicated that woodworking was part of their assignment. In small general aviation, woodworking continues to be performed by approximately one-third of the mechanics, but the frequency is in the low category. It was found that of 359 mechanics, only 126 were involved in woodworking tasks. The overall percentage of aviation mechanics surveyed in general aviation, large and small, who are responsible for performing woodworking is 10.8 percent.

10) Aviation mechanics must understand the basic operations involved in sheet metal work and must be able to make return to flight repairs to metal structures.

Findings reveal that the aviation industry requires more men to possess skill and knowledge in this topic area than in any other subtopic requiring manipulative skill. Representatives of the aviation industry stated that the mechanic must know which types of damage can be tolerated and which need repair. In all cases the work must be of a return-to-flight standard.

11) Aircraft welding is becoming a specialized skill.

The introduction of new materials in aviation and the new welding techniques require specialized skills for welders. Comments received from general aviation companies indicate that repairs involving welding are done by specialty shops. Specialization in welding is also applicable in the airline industry. In order to become a certificated welder, a mechanic must receive specialized instruction.

12) The use of manufacturer's specifications and Federal Air Regulations are an essential part of the aviation mechanics occupation.

Mechanics in all four categories indicated that manufacturer's specifications and Federal Air Regulations are used at a high frequency. The number of mechanics who use these publications and manuals is also very high. The airline industry and large general aviation provide basic and general information training in these tasks.

13) To be employable, the mechanic must have a sound command of the English language.

The importance of a mechanic's ability to read, write, and speak the English language is in most cases a fundamental requirement for acceptable performance and for advancement in the industry. Industry personnel repeatedly stressed during the survey that if a mechanic cannot meet this requirement in a satisfactory manner, he is not employable. The number of mechanics and the frequency with which this major topic is required is understandably very high. Accuracy in the use of the English language was emphasized throughout the findings. However, large general aviation required both accuracy and speed. The schools have a responsibility to ensure that their students are able to meet the standards for performance required in this area.

14) Ethics and the mechanic's legal responsibilities are an important part of the aviation mechanic's training.

This is the only major topic in the study where the subtopics were consistently ranked at the synthesis level in technical knowledge by all industrial categories. Since the definition of the synthesis level would be at times difficult to apply in this area, it only tends to emphasize how strongly the industry feels about the importance of the ethical responsibilities of the mechanic. The survey indicates that the widespread and high frequency requirements for the mechanic's integrity, quality of workmanship, and responsible action in the work environment will continue to be an essential part of the occupation.

15) The aviation industry provides extensive in-service training for the maintenance of occupational currency.

The in-service training for mechanics is designed to provide currency when new models of aircraft are introduced and changes occur in existing models. The amount of training is substantial and is generally directed to the basic and general information level. Training in depth is most predominant in the airline overhaul category. Industry training ranged from 81 percent in airline line stations to 85 percent in airline overhaul stations in all subtopics. Training in the general aviation industry ranged from 66 percent in small general aviation to 92 percent in large general aviation for all subtopics.

Redirection, Application, and Projections

Redirection

To ascertain the direction aircraft mechanic schools should take in developing an effective aviation mechanic's instructional program, an analysis of the training provided by industry and the schools should be made. This study, plus a subsample study that is discussed in detail in this section, identified industry's efforts to provide instructional programs for aviation mechanics. A review of the school programs in ATEC's 1965 Survey of Federal Aviation Agency Approved Mechanic School Programs outlines the efforts made by aviation mechanic schools to train aviation mechanics.

INDUSTRY EFFORTS

Two studies were made to determine what the aviation industry was doing to provide training for the certificated mechanic. The first of these was the national Study of the Aviation Mechanics Occupation; the second was the subsample study whose objective was the examination of the recency of the mechanics' in-service training, which was undertaken on the recommendation of the National Advisory Committee.

In the Study of the Aviation Mechanics Occupation it was found that industry training efforts for aviation mechanics ranged from orientation through basic or general training to training in depth. A number of the subtopics represented tasks for which industry offered no training.

As shown in Fig. 6 following, industry's training efforts are concentrated on basic and general information training. The training provided is designed to keep mechanics current with new models of aircraft and the changes that occur in existing aircraft. Training in depth is shown to be more prevalent in the airlines than in general aviation.

LEVEL TO WHICH TRAINING IS OFFERED	INDUSTRIAL CATEGORIES OFFERING TRAINING			
	Airline Line	Airline Overhaul	Large General	Small General
No training	19%	15%	8%	34%
Orientation or familiarization training	7%	4%	4%	zero
Basic or general information	55%	39%	72%	63%
Training in depth	19%	42%	16%	3%

Fig. 6. Percent of subtopics for which training is given by the aviation industry

The second study was the subsample study to examine recency of in-service training. The questionnaire was designed to answer three major questions: When was in-service training last received by the mechanic; where was instruction obtained (schools, industry, or both); and what type of instruction was received (formal, informal, or correspondence).

A total of 446 subsample questionnaires were completed by mechanics representing all four industrial categories. The distribution of the responses was: airline line stations, 234 mechanics; airline overhaul stations, 59 mechanics; large general aviation companies, 112 mechanics; and small general aviation companies, 41 mechanics.

Incidental information shown on the questionnaire regarding the mechanics' date of certification and the type of in-service training they received in each of the 52 major topics used in the national study was also examined. The subsample survey instrument was not designed to correlate the major topics with the type of training received and where the training was given.

Date	No.	Date	No.	Date	No.	Date	No.	Date	No.
1930	1	1939	2	1946	20	1953	16	1960	24
1931	1	1940	4	1947	34	1954	10	1961	14
1932	1	1941	4	1948	18	1955	25	1962	14
1933	2	1942	8	1949	17	1956	22	1963	15
1934-36	0	1943	5	1950	20	1957	17	1964	18
1937	1	1944	6	1951	17	1958	23	1965	25
1938	3	1945	13	1952	10	1959	29	1966	1

Fig. 7. Date of certification and number of respondents certified by year

The mechanics who responded to the subsample survey reported having received their certificates during the past 36 years (Fig. 7). None of the respondents was certified during the years 1934, 1935, and 1936. Beginning in 1945, an average number of 20 respondents received their mechanic certificates each year. The increase in the number of certificates issued in 1947 may be explained as an effect of the Serviceman's Readjustment Act of 1944.

Figure 8 following displays the years in which in-service training was last received. No in-service training was reported for the years 1945, 1946, 1949, 1950, 1951, and 1952. Of the 446 mechanics who responded, 383 men, or 86 percent, reported in-service training received since certification. The remaining 14 percent of the mechanics reported no in-service training received since certification.

Figure 8 also shows that 269, or 70 percent, of the respondents received in-service training in 1965 and 1966; an additional 56 mechanics, or 15 percent, reported in-service training received in 1964; and 26 respondents, or 7 percent, indicated in-service training received in

1963. Thus, a total of 92 percent of the respondents is shown to have received in-service training within the last three years. The training reported by the remaining 8 percent during the following periods is shown to have occurred in this distribution: 1960-62, 16 mechanics (4%); 1954-59, 11 mechanics (3%); and 1944-53, 5 mechanics (1%). Years in which no training was received have been omitted from Fig. 8.

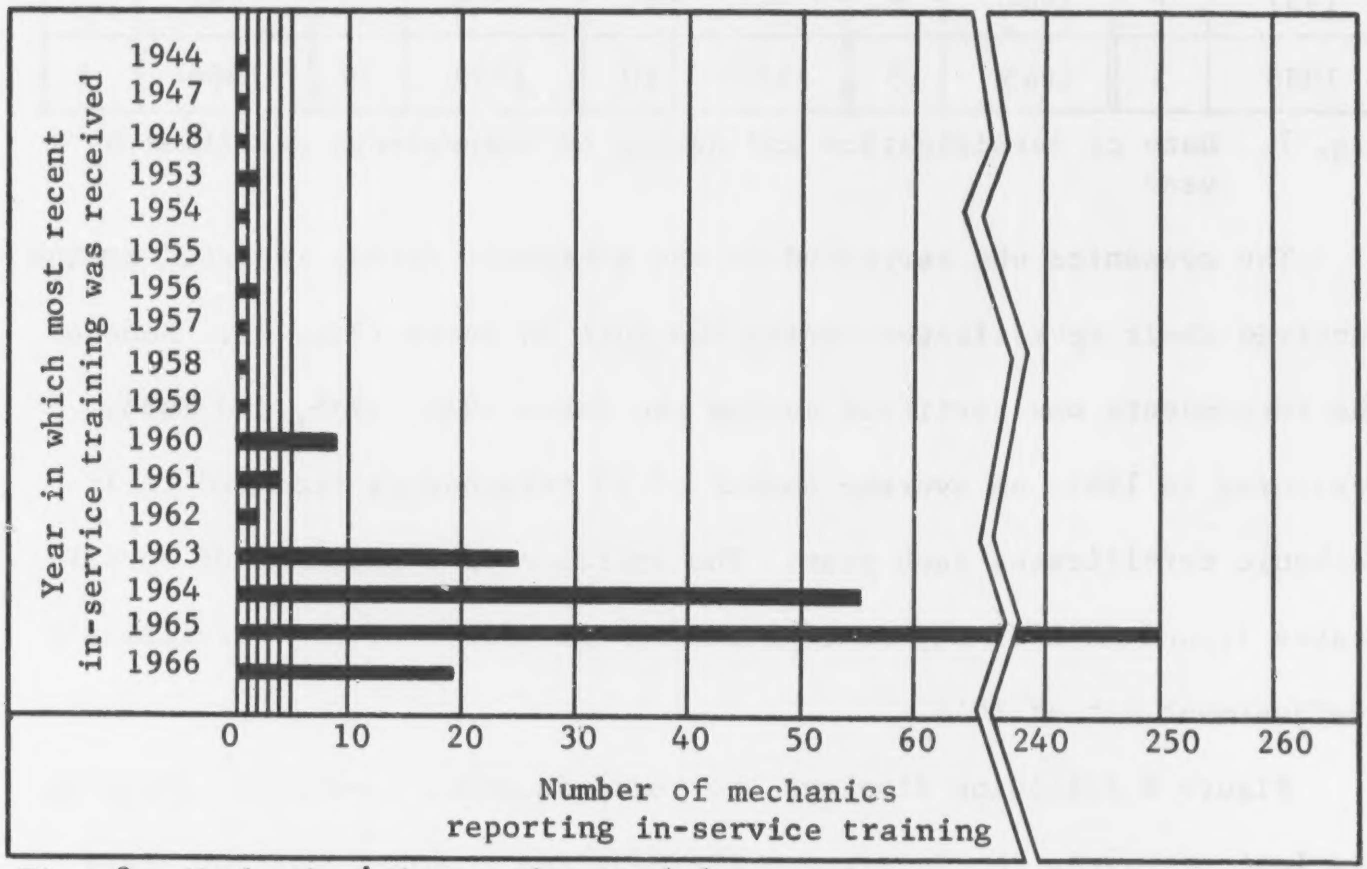


Fig. 8. Mechanics' in-service training

A review of Fig. 9 opposite reveals that formal instruction was the most common approach to in-service training. In descending order of frequency, the combination of both formal instruction and informal on-the-job training was the next most frequently used; informal on-the-job instruction was the third most frequent approach to in-service training. Only mechanics employed in the small general aviation industry indicated that they had received in-service training solely through correspondence courses.

TYPE OF INSTRUCTION	A	O	L	S
Formal classroom instruction	40%	40%	30%	28%
Informal on-the-job instruction	7%	10%	14%	17%
Combination of formal and informal instruction	18%	17%	20%	17%
Correspondence courses	--	--	--	2%
Formal instruction and correspondence courses	5%	10%	1%	2%
Informal instruction and correspondence courses	2%	--	2%	7%
Combination or formal, informal, and correspondence courses	18%	13%	5%	2%
Indicated no in-service training	10%	10%	28%	25%

Fig. 9. Means by which in-service training was obtained

Figure 10 presents evidence that in-service training is provided by both industry and the schools. The respondents to the subsample survey reported that most of their in-service training was provided by the aviation industry. This data supports the findings in this study, which

	IN-SERVICE TRAINING PROVIDED BY:		
	Industry	Schools	Both
Airline line mechanics	164	16	41
Airline overhaul mechanics	44	2	7
Large general aviation mechanics	66	3	10
Small general aviation mechanics	24	5	1

Fig. 10. Sources of in-service training

also indicated that industry is providing much training to maintain the technological currency of the aviation mechanic.

Application

In addition to teaching the various levels of technical knowledge recommended by the National Advisory Committee, the schools should develop and use written and manipulative examinations to determine that the level of teaching had been reached. These examinations may provide information concerning the student's rate of progress toward the established educational objectives for the subtopics contained in their school curriculum. A review of these levels and correlated sample questions follow. The examination material that appears in this section of the study has been adapted in part from the Study of the Aviation Mechanics Occupation (California study) published earlier in 1966.

TEACHING LEVEL 1: TESTING LEVEL, KNOWLEDGE

The subtopics to be taught at this level should be based on Instructional Setting A or E. The instruction should help the student learn to follow directions and to find information. The student should be expected to store some information and be able to recall this information later. Sample written questions to be given at the knowledge level are as follows:

1. The ratio of the speed of an aircraft to the speed of sound in air at any given temperature is called (the):

   a. Reynold's number
   b. Mach number
   c. Speed-temperature ratio
   d. Inlet-exhaust pressure ratio

2. Basically, the aircraft gas turbine engine operates under the description of the:

a. Otto cycle engine
b. Brayton, or Joule, cycle
c. Constant pressure engine
d. Constant volume engine

3. Ohm's Law is stated in which one of the following formulas?

a. I = R/E
b. E = IR
c. R = EI
d. I = IRE

TEACHING LEVEL 2: TESTING LEVEL, COMPREHENSION

The subtopics to be taught at this level should be based on Instructional Setting B or F. The student should be able to grasp the meaning and intent of the instruction. He should have an ability to interpret information in manuals, blueprints, and other related diagrams and drawings needed in performing a task. Sample questions at the comprehension level are as follows:

1. Based on the given cable chart, what size cable is required to carry 200 amps at 28 volts for a distance of 25', under intermittent conditions, to a turbine engine starter?

a. #2
b. #4
c. #6
d. #8

2. Based on the accompanying aircraft specifications, to which one of the following maximum weights may an aircraft in the utility category be loaded without exceeding the c.g. limits of +36.3" to +40.3"?

a. 1,733 lbs.
b. 2,200 lbs.
c. 3,453 lbs.
d. 4,000 lbs.

3. "Valve overlap" may be defined by which one of the following statements?

a. Improperly lapped valve seats
b. Degrees of crank rotation during which the exhaust and intake valves of a cylinder are both open
c. Undercutting of valve faces during lapping
d. Improper clearance adjustment between the valve stem and tappet

An examination in the performance of a manipulative skill could require a student to interpret engine overhaul limits from a manual, using these limits to inspect for wear of engine parts. Another type of test could require a student to compute, through the bend allowance formula, a sheet metal part containing several different angular bends.

TEACHING LEVEL 3: TESTING LEVEL, APPLICATION

The subtopics to be taught at this level should be based on Instructional Setting C or G. The student should develop knowledge of principles and processes and learn to apply them to specific situations. The student must remember appropriate principles and be able to apply them to new material. The instruction should provide detailed training in both technical and manipulative skills so that recall can be easily accomplished after the student has been employed and given additional review. Sample questions at the application level are as follows:

1. The purpose of a brake de-booster is to lower the pressure of the hydraulic system when applying the brakes by:

a. Providing a larger piston area for the hydraulic pressure to act upon
b. Providing a smaller piston area for the hydraulic pressure to act upon
c. Isolating the system pressure from the lower pressure
d. Installing a restrictor in the line to the brake

Below are statements that may support the selection of your answer above.

Circle the number of those statements that support your answer:

1. A restrictor causes a pressure drop, thus lowering pressure.
2. Increased piston area increases pressure.

3. Decreased piston area increases pressure.
4. Increased piston area decreases pressure.
5. Decreased piston area decreases pressure.
6. Force is equal to the product of pressure and area.
7. Force is equal to pressure per unit area.
8. Secondary system pressure to brakes is isolated by second pump.
9. The brake has its own pressure regulator.
10. Venturi effect of a restrictor increases velocity and decreases pressure.

2. Bernoulli's Principle indicates that if a smaller venturi is used in a carburetor, it will:

a. Decrease the air velocity and pressure
b. Increase the air velocity and decrease the pressure
c. Increase the air pressure and obtain more power
d. Increase the flow of air and gasoline

In relation to your answer, the following statements are true or false. If the statement supports your selection, circle the "T"; if it does not, circle the "F."

T F A smaller venturi will decrease manifold pressure.
T F A large venturi permits higher engine RPM.
T F Air pressure increases as the square of the velocity.
T F A smaller venturi will increase manifold pressure.
T F A large venturi is more effective at take-off power.
T F A smaller venturi makes the idle system more effective.
T F A small venturi increases the pressure at the discharge nozzle.
T F A large venturi provides more manifold pressure.
T F More air flow through the venturi causes more gas consumption.
T F A smaller venturi is more effective at higher altitudes.

3. If a shunt wound generator has a short between the armature and field:

a. The output will drop to zero
b. The generator will run away
c. The circuit voltage will drop
d. The "D" lead voltage will increase

By circling the numbers in front of the items below, indicate those you would use to check for the trouble you identified above:

1. Check resistance of generator field.
2. Check for shorted brushes.
3. Check for broken bearing.
4. Check reverse current relay.
5. Readjust current limiter.

6. Readjust voltage regulator.
7. Check resistance from "D" lead to ground.
8. Check armature to see if it is hitting the pole shoes.
9. Check ammeter for accuracy.
10. Check generator for sheared shaft.

An examination for manipulative skill should require the student to plan his work, select the proper tools, perform the job in sequence, complete the job in a reasonable time, and turn out a finished product that meets high standards of workmanship, accuracy, and dependability. The performance test must give a realistic appraisal of the student's ability. A check list should be used to evaluate the student's performance during the examinations and his overall rating. The check list items should be stated so that an objective rating may be established.

TEACHING LEVEL 4: TESTING LEVEL, ANALYSIS/SYNTHESIS

The subtopics to be taught at the analysis and the synthesis level should be based on Instructional Setting D or H. The student should develop the ability to reduce a malfunction to its fundamental parts in order to troubleshoot or make necessary repairs. The instruction must include training in depth in both technical and manipulative skills to facilitate transfer of learning with minimum difficulty. Through analysis, the students should be able to break down each job into its parts and examine the relationships between the parts. Sample questions at the analysis/synthesis level are as follows:

1. The following logbook item is written for an aircraft having "spot brakes": Upon application, brakes were inoperative." Check the items below that you would use in troubleshooting the item. Begin by writing the number "1" in front of the first item you would check, and continue numbering in the sequence you would use to isolate the trouble.

____Check for air in the brake lines.
____Check for broken brake accumulator diaphragm.
____Check hydraulic tank for fluid.
____Check system pressure.

____Check for disconnected link between brake pedal and metering valve.
____Check for pucks missing from spot brake.
____Check for broken line downstream of brake metering valve.
____Check for ruptured brake cylinder.
____Check for too great a brake clearance.
____Check for leak in main system.

2. The following logbook entry appears concerning an aircraft with Hamilton Standard Constant Speed Propeller: "Upon take-off, propeller emains in low pitch. Unable to increase propeller pitch angle. See previous logbook entries." Upon reviewing the logbook, you find that two governors have been replaced because of broken drive shafts. You suspect one of the following troubles:

a. Malfunction in the engine oil system
b. Improper torqueing of governor
c. Internal engine damage

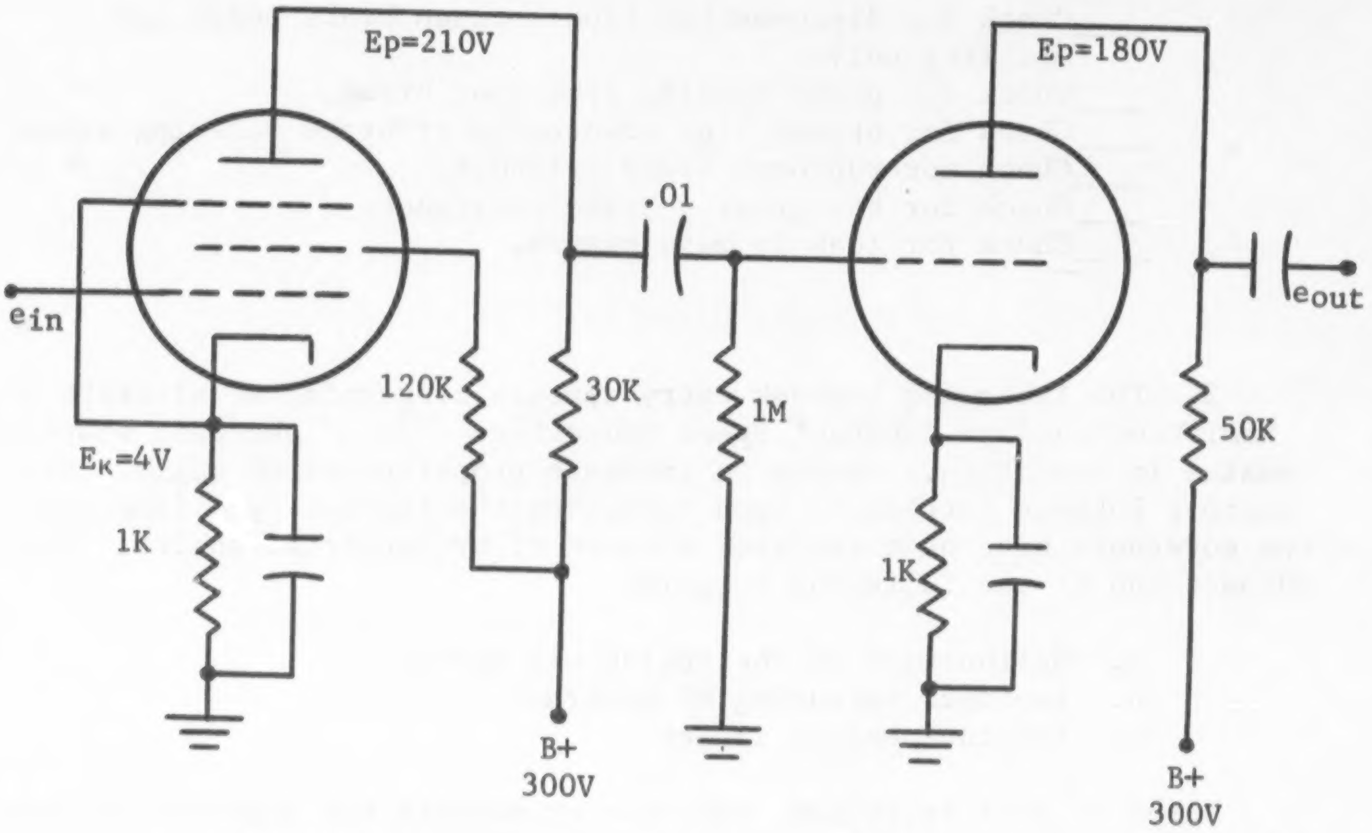
Based on your selection, indicate by numbers the sequence you would follow to solve the problem you selected as the cause of the trouble.

Engine oil system
____Check oil level.
____Check oil pressure.
____Check for oil leakage around dome.
____Check for proper oil viscosity.

Improper torqueing of governor
____Check stress on threads of nuts.
____Check for proper gasket.
____Check for stud stretch.
____Check break-away torque.

Internal engine damage
____Check for slipping drive spline.
____Check for proper length of governor shaft.
____Check for missing tooth on drive gear.
____Check for damage spline on drive spline.

3. A 2-stage amplifier is used to position a wastegate motor. During service, the motor becomes sluggish. The motor and interconnecting wiring checks out OK. A mechanic suspects the amplifier. Several quiescent voltage readings are indicated on the wiring diagram in the maintenance manual; however, the V_1 screen grid voltage is not indicated. What should this voltage be?



a. 80 volts
b. 120 volts
c. 180 volts
d. 210 volts

This voltage was arrived at by one of the following methods of analysis. Which of these was used?

1. The screen voltage and plate voltage are the same.
2. The screen voltage equals the supply voltage minus the IR drop.
3. Screen grid current is zero.
4. Cathode current is zero.
5. No signal is applied under quiescent conditions.
6. The amplifiers are both operating as class "A."
7. There is not enough information given above.

A performance test should not only include the standards and methods used for testing at the application level, but should also measure how well and quickly a student can identify and isolate the cause of a malfunction. Many schools have students troubleshoot engines, hydraulic systems, electrical systems, etc., that have been made to function improperly, and these types of tests meet the requirements of an analysis examination. However, as in the case of the application level examinations, a check list should be used that will give objective ratings of the student's performance during the examination.

Instruction at the synthesis level requires the student to develop the ability to put together knowledge of principles and procedures needed to complete repairs. This includes the construction of new or substitute parts. The instruction presented to the student must be in depth both in technical and manipulative skill to facilitate transfer of learning with minimum difficulty. Although few subtopics recommended for instruction are at the synthesis level, those that are should call upon the student to demonstrate his ability to create original repair ideas within limits of time and material. The following problem example is appropriate for this level of instruction. Taken from the flight crew logbook, the information concerns an axial compressor turbine engine.

> "During start of descent from 30,000 ft., while at 500 KTAS, No. 4 engine experienced a compressor stall lasting approximately 3 secs. as all four throttles were being retarded from the 85% thrust to idle position. Other observed conditions for No. 4 engine were: (1) fuel flow increased from 3,000 pph to 3,500 pph; (2) engine speed dropped to 5,000 rpm from 10,000 rpm; (3) exhaust gas temperature increased to 650°C."

The student is required to write a comprehensive report of the problem. The report should contain an analysis of the probable causes of the malfunctions, a detailed outline of the inspection to be performed on the engine, a list of repairs to be made, and the scope of engine testing to be done before the aircraft is released to flight status.

An examination of manipulative skill could require the student to develop a creative design or procedure for the repair or maintenance of an aircraft or one of its components. The examination must permit creative answers, and the student should have time to develop his answer. The test may require the student to design a new structural repair by outlining the sequential steps needed to perform the job, designing and fabricating the new parts required, and then completing the entire job. Many students will not be able to perform completely at the synthesis level; however, instruction at Level 4 should give the student training that will permit him to work in industry at a high level of proficiency.

The information accumulated during the national survey and the recommendations of the National Advisory Committee together identify the subtopics that compose the core curriculum for the aviation mechanics course of instruction. Use of the suggested levels of instruction in this curriculum will assist aviation mechanics schools in their efforts to provide more effective instruction.

OUTLINE OF CORE CURRICULUM

The following core curriculum is a compilation of the recommendations made by the National Advisory Committee. The curriculum lists and identifies the teaching and testing levels for each of the subtopics. Following this curriculum outline is a compilation of all other subtopics that were surveyed and recommended for deletion from the core curriculum. It is suggested that schools review these deleted topics and, upon recommendation of their local advisory committee, utilize the information presented for curriculum construction that would best serve their local needs.

In reading the following curriculum, it should be noted that the subtopics are listed under the Teaching Levels: 1, 2, 3, or 4, and the Testing Levels: Knowledge, Comprehension, Application, or Analysis/Synthesis.

WOODWORK

Level 1 - Knowledge

Make rib repair
Use glues and clamps
Build a rib
Build wing section
Make spar splice
Use NACA airfoil specifications
Construct jigs
Select materials
Handle and store wood
Test strength of splices
Make approved splices

Level 2 - Comprehension

Identify wood defects

FABRIC COVERING

Level 1 - Knowledge

Select materials
Cover wing, structure, or control surface

Level 2 - Comprehension

Perform hand sewing

Level 3 - Application

Repair fabric
Perform fabric protection and testing

PAINTING AND FINISHING

Level 1 - Knowledge

Lay out letters and mask
Lay out trim design
Touch up painting

Level 3 - Application

Brush painting
Spray painting
Inspect and identify defects
Prepare surface and prime
Apply dope

SHEET METAL

Level 1 - Knowledge

Maintain aerodynamic smoothness

Level 2 - Comprehension

Install special rivets
Install special fasteners
Fabricate from template
Develop template from blueprint
Shape metal, i.e., hot working, cold working, casting, chemical milling, etc.

Level 3 - Application

Hand forming
Use bend allowance
Identify and control corrosion (Theory only.)
Repair structure
Use adhesive metal bonding
Inspect and repair plastics and fiberglass
Repair honeycomb and laminated structure

Level 4 - Analysis/Synthesis

Install conventional rivets
Dimple metal
Make patches
Protect metal from damage (No manipulative skill training.)

WELDING

Level 1 - Knowledge

Solder stainless steel
Fabricate tubular structures
Repair tanks
Weld magnesium
Weld titanium

Level 2 - Comprehension

Weld aluminum

Level 3 - Application

Solder
Identify types of welded joints (Theory only.)
Weld stainless steel

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Arc welding
Control alignment while welding
Inspect and test welds
Weld steel (gas)
Braze

ASSEMBLY AND RIGGING

Level 1 - Knowledge

Use transit

Level 2 - Comprehension

Rig fixed surfaces
Rig aircraft
Tram and align structure

Level 3 - Application

Rig moveable surfaces
Balance control surfaces
Assembly of aircraft

Level 4 - Analysis/Synthesis

Use manufacturer's and FAA specifications

LANDING GEAR

Level 2 - Comprehension

Service and repair leveling devices
Service and repair anti-skid devices

Level 3 - Application

Service and repair landing gear
Inspect and replace tires and wheels
Service and repair shock struts
Service and repair nose wheel steering
Service and repair brakes
Jack aircraft and test gear
Inspect damage and wear to limits
Check alignment

HYDRAULIC AND PNEUMATIC SYSTEMS

Level 3 - Application

Operate and service hydraulic system and components
Operate and service pneumatic system and components
Identify various types of hydraulic systems
Identify various types of pneumatic systems
Identify hydraulic fluids
Install fittings and lines
Inspect and repair hydraulic system and components
Inspect and repair pneumatic system and components

Fabricate aluminum lines
Fabricate stainless lines
Select and install "O" rings and seals

FUEL SYSTEM

Level 1 - Knowledge

Service fuel dump systems
Repair and seal fuel tanks

Level 2 - Comprehension

Identify fuel systems

Level 3 - Application

Check and service fuel systems and components
Identify fuels
Fabricate and replace lines and fittings
Inspect and repair fuel system components

AIR CONDITIONING AND PRESSURIZATION

Level 2 - Comprehension

Check and service pneumatics and heat exchangers
Inspect, replace, or repair pneumatic system components (No manipulative skill training.)
Inspect, replace, or repair air conditioning components
Check and service heat and cooling systems and their control systems
Check and service aircraft pressurization and control systems
Inspect, replace, or repair pressurization components (No manipulative skill training.)
Inspect, replace, or repair oxygen systems and components (No manipulative skill training.)
Troubleshoot and repair air conditioning and pressurization systems

Level 3 - Application

Check and service oxygen systems

ELECTRICAL POWER

Level 1 - Knowledge

Apply electrical measuring and indicating devices for checking and measuring capacitance
Apply electrical measuring and indicating devices for checking and measuring inductance

Level 2 - Comprehension

Apply electrical measuring and indicating devices for calculation of resistance and conductivity
Check and replace transformers, rectifiers, and filters
Apply electron theory and fundamentals of electromagnetism in troubleshooting aircraft AC power systems

Apply electrical measuring and indicating devices for measurement and calculation of power
Test and repair aircraft generator and inverter control systems
Test and repair solid state inverters and switching devices

Level 3 - Application

Apply electron theory and fundamentals of electromagnetism in reading and analyzing DC and AC circuits and diagrams
Apply electron theory and fundamentals of electromagnetism in operation and testing DC and AC electrical components
Apply electrical measuring and indicating devices for measurement of voltage, current, and resistance
Apply electrical measuring and indicating devices for checking of continuity and electrical leakage
Promote and practice electrical safety and hazard precautions
Apply electron theory and fundamentals of electromagnetism in troubleshooting aircraft wiring and electrical installations
Troubleshoot and replace DC and AC motors and control units
Check and replace relays, solenoids, switches, and rheostats
Check and replace electrical protective devices
Apply electron theory and fundamentals of electromagnetism in troubleshooting aircraft DC power systems
Apply electrical measuring and indicating devices for checking and testing thermocouples
Troubleshoot and replace DC and AC generator equipment
Install and repair electrical wiring and distribution equipment
Apply battery theory and test equipment to maintain and test lead acid batteries
Apply battery theory and test equipment to test and maintain Edison cells and nickel cadmium batteries
Apply battery theory and test equipment to operate and maintain battery chargers
Check and troubleshoot solid state inverters
Inspect, test, and repair aircraft motors, generators, and inverters
Check and troubleshoot solid state switching devices

FLIGHT INSTRUMENTS

Level 2 - Comprehension

Troubleshoot and maintain magnetic compasses and heading indicators
Troubleshoot and maintain airspeed indicators and machmeters
Troubleshoot and maintain altimeters, rate-of-climb, and vertical speed indicators
Troubleshoot and maintain clocks and elapsed time indicators
Troubleshoot and maintain turn and bank, horizon, and yaw instruments
Troubleshoot and maintain temperature and pressure instruments
Troubleshoot and maintain flap and control surface position indicators
Troubleshoot and maintain pitot static, ram air, and vacuum systems
Troubleshoot and maintain resistance and thermocouple indicator systems
Troubleshoot and maintain synchro remote indication systems
Troubleshoot and maintain electronic indicating and computing systems
Troubleshoot and maintain integrated type of flight instrumentation

Test and repair compasses and heading indicator systems (No manipulative skill training.)
Test and repair airspeed, rate-of-climb, and altitude indicator systems (No manipulative skill training.)
Test and repair temperature and pressure indication systems
Test and repair electronic computers and integrating systems
Test and repair synchro systems and magnetic amplifiers

AUTO PILOTS AND APPROACH CONTROLS

Level 1 - Knowledge

Inspect, test and repair auto pilot control and interlock systems
Troubleshoot and maintain auto approach control
Inspect, test and repair auto pilot and approach control amplifiers, computers and couplers
Troubleshoot and maintain glide path extension and related data computers
Inspect, test and repair auto pilot flight control servos and drive mechanisms
Inspect, test and repair auto pilot signal source systems and units

Level 2 - Comprehension

Operate and check auto pilot and approach control systems (No manipulative skill training.)
Troubleshoot and maintain flight control servo units (No manipulative skill training.)
Check and troubleshoot auto pilot interlock systems (No manipulative skill training.)
Troubleshoot and replace auto pilot and approach control computers and amplifier units (No manipulative skill training.)
Troubleshoot and maintain auto pilot signal source units (No manipulative skill training.)
Troubleshoot and maintain power supplies and phase control (No manipulative skill training.)
Troubleshoot and maintain horizontal stabilizer control and mach trim systems (No manipulative skill training.)
Troubleshoot and maintain yaw damper systems (No manipulative skill training.)

AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT

Level 1 - Knowledge

Inspect and repair control units and panels
Check, troubleshoot and replace HF receiver and transmitter systems
Check, troubleshoot and replace service and passenger compartment interphone systems
Check and replace DME and DMET systems and off course computers
Check and replace weather radar systems
Check and replace selcal and transponder systems
Check and replace flight directors, data computers and integrating systems
Check and replace loran, doppler radar, radar altimeters
Check and replace radio altimeters and terrain clearance indication systems
Check and replace flight recorders

Level 2 - Comprehension

Inspect and repair antenna installations
Inspect and repair radio racks and related equipment
Inspect and repair radio and electronic wiring, switching and protective systems
Operate and check aircraft HF and VHF radio receivers and transmitters
Check, troubleshoot and replace VHF receiver and transmitter systems
Check and replace gyro and radio compass systems
Check and replace ADF and VOR systems
Check and replace marker, localizer, and glide slope receivers
Inspect and repair headsets, microphones, and speakers
Check, troubleshoot and replace flight compartment interphone systems

ENGINE INSTRUMENTS, ELECTRICAL

Level 1 - Knowledge

Troubleshoot and replace rate-of-flow indication systems

Level 2 - Comprehension

Troubleshoot and replace pressure indication systems
Inspect, test and repair engine indicating system components

Level 3 - Application

Inspect, test and repair electrical connections and wiring
Inspect, test and repair instrument panels and unit mountings
Inspect, test and repair electric connectors
Troubleshoot and replace temperature indication systems
Troubleshoot and replace tachometers and RPM indicators

AIRCRAFT FUEL AND OIL MEASUREMENT AND CONTROL

Level 1 - Knowledge

Calibrate and test capacitance fuel and oil quantity indication systems

Level 2 - Comprehension

Perform fuel management, transfer and defueling
Troubleshoot and replace fluid pressure and temperature indication systems
Troubleshoot and replace fluid system warning devices
Calibrate and test float type fuel and oil quantity indication systems
Inspect and repair fluid quantity indication equipment (No manipulative skill training.)
Troubleshoot and replace pressure refueling control equipment (No manipulative skill training.)

Level 3 - Application

Troubleshoot and replace fuel and oil electric pumps, valves and their controls
Troubleshoot and replace fluid quantity indication systems
Inspect and repair fuel and oil pumps, valves and other control units
Inspect and repair pressure and temperature indication and warning systems

AIRCRAFT LANDING GEAR ELECTRICAL UNITS

Level 1 - Knowledge

Inspect, test and replace speed warning components
Inspect, test and replace take-off warning components
Check and troubleshoot electrical brake controls and anti-skid control systems

Level 2 - Comprehension

Check takeoff warning systems (No manipulative skill training.)

Level 3 - Application

Troubleshoot landing gear position indication and warning systems
Check and troubleshoot ground flight changeover switches and relays
Inspect, test and replace landing gear and gear door switches
Inspect, test and replace ground flight switches and relays

FIRE DETECTION AND EXTINGUISHING SYSTEMS

Level 1 - Knowledge

Check and service smoke and carbon monoxide detection systems
Inspect, replace or repair smoke detection components

Level 2 - Comprehension

Check and service fire extinguishing systems (No manipulative skill training.)

Level 3 - Application

Check and service bimetallic, thermocouple and continuous strip fire detection systems
Inspect, replace or repair compartment fire detectors and system components
Inspect, replace or repair fire extinguishers and related system components
Inspect, replace or repair engine and nacelle fire detection components

ICE AND RAIN CONTROL

Level 2 - Comprehension

Check and service powerplant ice control systems (No manipulative skill training.)
Check and service air scoops and leading edge ice control systems
Check and service electrical windshield ice control systems
Check and service antennas, accessories and pitot static devices
Troubleshoot and repair windshield rain removal and window defogging systems
Inspect and repair air scoops and leading edge ice control systems
Inspect and repair windshield ice control systems
Check and service pneumatic windshield anti-icing and defogging systems

Level 3 - Application

Inspect and repair powerplant ice control components

WARNING SYSTEMS

Level 1 - Knowledge

Inspect and repair warning system components

Level 2 - Comprehension

Check and service hydraulic power and system components
Check and service ice and rain protection
Check and service lights and lighting
Check and service doors and emergency windows
Check and service flight controls, flaps, spoilers and leading edge devices
Check and service powerplant starting and vibration
Check and service overspeed and underspeed
Check and service electrical, pneumatic and oxygen systems

RECIPROCATING ENGINES

Level 2 - Comprehension

Inspect and repair fourteen cylinder radial engine or larger
Overhaul fourteen cylinder radial engine or larger

Level 3 - Application

Check and service fourteen cylinder radial engine or larger
Remove and install engine
Check and service cylinder
Inspect and repair gear reduction section
Inspect and repair supercharger
Operate engine
Inspect and repair four or six cylinder opposed engine
Inspect and repair seven or nine cylinder radial engine
Check and service gear reduction section
Check and service supercharger
Overhaul gear reduction section
Overhaul supercharger

Level 4 - Analysis/Synthesis

Identify types and principles of reciprocating powerplants (No manipulative skill training.)
Inspect and repair cylinder
Troubleshoot
Check and service four or six cylinder opposed engine
Check and service seven or nine cylinder radial engine
Overhaul four or six cylinder opposed engine
Overhaul seven or nine cylinder radial engine
Overhaul cylinder

TURBINE ENGINES

Level 1 - Knowledge

Overhaul turbofan
Overhaul accessories
Overhaul turboprop

Level 2 - Comprehension

Inspect and repair accessories
Check and service turbofan
Inspect and repair turbofan

Level 3 - Application

Remove and install engine
Inspect and repair turbojet
Check and service accessories
Check and service turbojet
Operate engine
Overhaul turbojet
Check and service turboprop
Inspect and repair turboprop

Level 4 - Analysis/Synthesis

Identify types and principles of turbine engines (No manipulative skill training.)
Troubleshoot

LUBRICATING SYSTEMS

Level 2 - Comprehension

Inspect and repair coolers and temperature regulators

Level 3 - Application

Identify types of lubrication systems
Identify types and specifications of lubricants
Check and service coolers and temperature regulators
Check and service pumps and valves
Check and service seals and other components
Check and service tanks and lines
Inspect and repair pumps and valves
Inspect and repair tanks and lines
Inspect and repair seals and other components
Adjust pressure
Inspect and repair oil dilution system
Check and service oil dilution system

IGNITION SYSTEMS

Level 3 - Application

Identify special dangers of high energy systems
Check and service turbine ignition systems
Check and service low tension systems
Inspect and repair turbine ignition systems
Check and service booster starting systems
Check and service high tension systems

Level 4 - Analysis/Synthesis

Inspect and repair low tension systems and components
Inspect and repair booster starting systems
Inspect and repair high tension systems and components

FUEL METERING

Level 2 - Comprehension

Inspect, maintain, and test gas turbine fuel control units
Inspect, maintain, and test ADI systems
Trim turbine powerplants

Level 3 - Application

Inspect, maintain, and test carburetor de-icing and anti-icing
Check and service water injection system
Determine causes of detonation, auto ignition, etc.
Inspect, maintain, and test float carburetors
Inspect, maintain, and test injection carburetors
Inspect, maintain, and test injection nozzles

INDUCTION SYSTEM

Level 3 - Application

Inspect and maintain carburetor intake and intake pipes
Inspect and maintain heat exchangers

PROPELLER (GENERAL)

Level 1 - Knowledge

Apply theory of balance
Identify special propeller lubricants

Level 2 - Comprehension

Apply theory of thrust
Use propeller specifications

Level 3 - Application

Perform specialized propeller inspections
Perform propeller track
Use universal protractor

FIXED PITCH PROPELLERS (WOOD)

Level 1 - Knowledge

Refinish propeller
Balance vertical and horizontal

Level 3 - Application

Remove and install

FIXED PITCH PROPELLERS (METAL)

Level 1 - Knowledge

Refinish propeller
Balance vertical and horizontal

Level 3 - Application

Repair propeller (minor)
Remove and install

TWO POSITION AND CONSTANT SPEED PROPELLERS

Level 2 - Comprehension

Disassemble and assemble per manufacturer's specifications

Level 3 - Application

Apply theory of operation (No manipulative skill training.)
Remove and install
Check operation

CONSTANT SPEED FEATHERING PROPELLERS

Level 2 - Comprehension

Disassemble and assemble per manufacturer's specifications

Level 3 - Application

Apply theory of operation
Remove and install
Check operation

REVERSIBLE PROPELLERS (RECIPROCATING ENGINES)

Level 1 - Knowledge

Disassemble and assemble per manufacturer's specifications

Level 3 - Application

Apply theory of operation
Remove and install

REVERSIBLE PROPELLERS (TURBINE ENGINES)

Level 1 - Knowledge

Disassemble and assemble per manufacturer's specifications

Level 3 - Application

Apply theory of operation
Remove and install

GOVERNORS

Level 1 - Knowledge

Disassemble and assemble per manufacturer's specifications

Level 2 - Comprehension

Bench test

Level 3 - Application

Line inspection and adjustment
Apply theory of operation
Service synchronization system
Check and service bleed valve governor

DRAFTING

Level 1 - Knowledge

Use and care of essential drafting instruments and equipment
Draw projections

Level 2 - Comprehension

Care of blueprints
Use appropriate symbols i.e., hydraulic, electrical, etc.

Level 3 - Application

Use and interpret standard blueprint information
Interpret and apply data in title block, bill of materials, etc.
Draw shop sketches

WEIGHT AND BALANCE

Level 2 - Comprehension

Prepare and weigh aircraft
Measure moment arm
Compute weight and balance
Correct for adverse conditions or effects of improper loading
Record weight and balance data
Use terminology and symbols

Level 3 - Application

Use specifications, data sheets, and aircraft listing

AIRCRAFT MATERIAL AND PROCESSES

Level 1 - Knowledge

Utilize basic economic and engineering criteria in selection of materials
Use high energy forming processes

Level 2 - Comprehension

Develop an understanding of structure and composition of metals and their alloys such as SAE steels, corrosion resistant steel, copper, nickel, aluminum, magnesium, titanium, special high temperature metals, etc.
Perform basic heat treating and annealing processes
Identify physical properties of materials
Identify mechanical properties of materials
Identify windshield and window materials

Level 3 - Application

Identify standard hardware and materials
Use the technical terminology common to materials utilized in airframes and propulsion units
Identify types of corrosion and preventive measures
Identify piping color coding
Apply principles of adhesive bonding

INSPECTION FUNDAMENTALS

Level 1 - Knowledge

Use fundamentals of statistical inspection
Use non-destructive testing, chemical etching
Use non-destructive testing, hardness
Use non-destructive testing, ultrasonic
Use non-destructive testing, radiography (X ray)
Use non-destructive testing, eddy current

Level 2 - Comprehension

Use non-destructive testing, penetrants
Use non-destructive testing, magnetic particle

Level 3 - Application

Inspect for general source of wear and deterioration
Complete typical report forms and status tags
Use manufacturer's inspection data

Level 4 - Analysis/Synthesis

Use precision measuring devices, micrometers, height gages, etc.

AIRCRAFT AND ENGINE INSPECTION

Level 2 - Comprehension

Inspect aircraft (annual)
Inspect aircraft (overhaul checks)
Use general aviation inspection aids summary

Level 3 - Application

Perform and record inspections per manufacturer's FAA or progressive requirements
Inspect aircraft (walk around)
Use inspection guides
Use manufacturer's service bulletins

GROUND SUPPORT EQUIPMENT

Level 2 - Comprehension

Use hydraulic equipment
Use pneumatic equipment
Use electrical equipment
Use fuels, lubricants and fluids
Use line starting equipment

Level 3 - Application

Use ground fire protection

GROUND HANDLING

Level 1 - Knowledge

Use tow bars and towing equipment
Spot and moor aircraft
Taxi aircraft

Level 2 - Comprehension

Use standard line and taxi signals
Fuel aircraft
Perform pre-flight servicing
Perform post-flight servicing

Level 3 - Application

Jack aircraft

CLEANING AND CORROSION CONTROL

Level 1 - Knowledge

Identify applications and limitations of soaps and detergents
Identify applications and limitations of window and windshield cleaning agents
Use interior cleaning equipment and procedures
Use carbon removers
Use cleaning equipment and procedures for electrical component cleaning
Use cleaning equipment and procedures for ultrasonic degreasing

Level 2 - Comprehension

Use cleaning equipment and procedures for vapor degreasing
Inspect and determine adequacy of cleaning performed on airplanes
Use sand, shell, grit, and vapor blasting

Level 3 - Application

Identify applications and limitations of chemical solvents and paint removers flammability and explosion characteristics
Inspect for evidence of corrosion in critical areas
Apply principles of airplane cleaning and corrosion control

MATHEMATICS

Level 1 - Knowledge

Extract roots and raise numbers to given powers
Perform descriptive geometry as applied to template development and layout
Calculate areas and volumes of various geometric shapes

Level 2 - Comprehension

Perform layouts utilizing fundamentals of geometric construction

Level 3 - Application

Read and interpret graphs and charts
Calculate ratios, proportions and percentages
Perform algebraic operations involving subtraction, addition, multiplication and division of positive and negative numbers

Level 4 - Analysis/Synthesis

Add, subtract, multiply and divide

ENGLISH

Level 4 - Analysis/Synthesis

Read, write and speak the English language
Write clear, concise, grammatically correct technical reports normally expected of certificated mechanics
Use dictionary and standard reference books
Read pertinent technical data with comprehension

PHYSICS

Level 1 - Knowledge

Perform temperature conversions, problems involving relationships of gases and pressures and mechanical equivalents of heat
Perform necessary calculations to understand effect of speed of sound, frequency, pressure, loudness, reflection of sound waves, etc.

Level 2 - Comprehension

Solve gas and fluid problems such as pressure, volume, Pascal's Law, Bernoulli's Principle, etc.

Level 3 - Application

Perform calculations involving mechanics such as levers, pulleys, inclined planes, linear motion, etc.

CHEMISTRY

Level 1 - Knowledge

Apply chemical principles to electrolysis and its effect
Apply chemical principles to basic chemistry of fuels, lubricants and hydraulic fluids
Apply chemical principles to the basic chemistry of paints, lacquers and thinners

Apply chemical principles to the chemical reactions within batteries
Apply chemical principles to the chemistry of adhesives and sealing materials
Apply chemical principles to common elements and elementary compounds such as salts, bases, and acids

AIRCRAFT NOMENCLATURE

Level 3 - Application

Use proper aircraft nomenclature
Classify aircraft as to propulsion devices, wing arrangement, purpose, landing gear systems, etc.
Apply FAA aircraft categories and definitions as found in appropriate publications such as: FAR 1, 21, 23, etc.

THEORY OF FLIGHT

Level 2 - Comprehension

Interpret theory of flight in relation to rotary wing
Interpret theory of flight in relation to rotorcraft flight controls and their effects
Interpret theory of flight in relation to thrust torque and torque correction as applied to rotorcraft

Level 3 - Application

Interpret theory of flight in relation to reference axes of aircraft
Interpret theory of flight in relation to function of conventional controls and control surfaces
Interpret theory of flight in relation to high lift devices such as flaps, slats, etc.
Interpret theory of flight in relation to properties of the earth's atmosphere
Interpret theory of flight in relation to aircraft maneuvers such as turns, skids, stalls, etc.
Interpret theory of flight in relation to forces acting on an airfoil and airplane
Interpret theory of flight in relation to unconventional controls and control surfaces
Interpret theory of flight in relation to loads and effect of turbulence and speed
Interpret theory of flight in relation to wing loading, power loading, maneuvering speed, etc.

FAR AND RELATED PUBLICATIONS

Level 1 - Knowledge

File and index publications
Use of technical standard orders (TSO) and supplemental type certificate (STC)

Level 2 - Comprehension

Use flight safety mechanics bulletins

Level 3 - Application

Use specifications, data sheets, manuals, and publications on aircraft, engines and propellers
Use required federal air regulations
Interpret and use specifications such as MS, AC, AN, NAS and typical manufacturer's manuals
Interpret and use ATA specification 100
Know how and where to find pertinent data in FAA specifications
Use of logbooks and making maintenance record entries
Use and disposition of FAA forms
Use airworthiness directives (FAR 39)

SHOP MANAGEMENT RESPONSIBILITIES

Level 1 - Knowledge

Apply FAA regulations in repair station operation
Apply shop management principles to organization and assignment of personnel
Purchase parts and supplies
Perform elementary accounting
Perform inventory control of materials, equipment

Level 2 - Comprehension

Maintain required records
Perform job estimating

ETHICS AND LEGAL RESPONSIBILITIES

Level 1 - Knowledge

Practice the legal responsibilities of bailment
Practice the legal responsibilities of mechanics liens

Level 2 - Comprehension

Employ ethical practices related to mechanic/customer relationship

Level 3 - Application

Employ ethical practices related to job and product pride and craftsmanship
Employ ethical practices related to mechanic/employer relationship
Employ ethical practices related to the responsibilities of aviation
Employ ethical practices related to personal conduct and integrity
Practice the legal responsibilities of liability of the certificated mechanic

CORE CURRICULUM DELETION LIST

On the basis of a detailed review of all subtopics, the National Advisory Committee recommended deletions from the core curriculum for the following reasons: (1) task is obsolete, (2) task is highly specialized and training is generally provided by the industry, and/or (3) task is impractical for schools to teach because of the equipment, funds, or time required.

FABRIC COVERING

Inspect and repair structure for cover
Perform power sewing

ELECTRICAL POWER

Apply battery theory and test equipment to test and service dry battery equipment

AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT

Check, troubleshoot, and replace passenger announcement and entertainment systems

IGNITION SYSTEMS

Classify types of magnetos
Check and service battery ignition systems
Inspect and repair battery ignition systems

GROUND ADJUSTABLE PROPELLERS

Remove and install propeller
Disassemble and assemble per manufacturer's specifications
Repair blades and hub (minor)
Repitch propeller
Balance propeller

TWO POSITION AND CONSTANT SPEED PROPELLERS

Balance propeller
Overhaul propeller

CONSTANT SPEED FEATHERING PROPELLERS

Balance propeller
Overhaul propeller

REVERSIBLE PROPELLERS (RECIPROCATING ENGINES)

Overhaul propeller

REVERSIBLE PROPELLERS (TURBINE ENGINES)

Overhaul propeller
Check and service turboprop engine brake

GOVERNORS

Overhaul governor

DRAFTING

Use specifications and drafting room manuals
Draw intersections and developments
Draw lines, dimensions, sections, scales, etc.
Draw technical working drawings

WEIGHT AND BALANCE

Use loading graphs, center of gravity envelopes and loading schedules
Use FAA form and CAM 18

INSPECTION FUNDAMENTALS

Use destructive testing, tension
Use destructive testing, bending
Use destructive testing, impact

AIRCRAFT AND ENGINE INSPECTION

Check storage status of non-active aircraft

GROUND SUPPORT EQUIPMENT

Drive fuel trucks
Use ground air conditioner

GROUND HANDLING

Hoist aircraft

MATHEMATICS

Perform calculations common to right triangles and use of trigonometric tables.
Perform calculations involving use of slide rule

CHEMISTRY

Apply chemical principles to chemistry of plastics, both clear and reinforced
Apply chemical principles to the composition of matter - molecules, atoms, and electrons
Apply chemical principles to the chemistry of natural and synthetic fabrics
Use chemical symbols and equations
Use periodic table

Projections

The national Study of the Aviation Mechanics Occupation has been a positive endeavor to assist the aviation mechanics schools in their training programs. The research contained in this study stands alone as a significant step in the search for new approaches for the training of aviation mechanics. Methods to maintain curriculum currency for instruction and to expand in-service training for teachers of aviation mechanics must be developed. Experimental programs implementing the suggested core curriculum and introducing new instructional materials for teachers will continue as a follow-up to this study.

With the development of the recommended core curriculum, a system for introducing up-dated information into the curriculum now becomes necessary. Such a system will require re-evaluation of each subtopic in the core curriculum at regular intervals. This can be accomplished by selected qualified representatives of the four aviation industry categories. These representatives will begin by analyzing the data in this study and make recommendations for additions and deletions to the core curriculum, as well as corrections to the technical knowledge, manipulative skill, and industry training levels.

Procedures for making these evaluations will be carefully planned and monitored to ensure the validity of their recommendations. The results will then be presented to a national advisory review board having a representation similar to that of the National Advisory Committee that assisted this study. The review board will examine the industry findings, recommend changes as needed in the core curriculum, and communicate these recommendations to the aviation mechanic schools. It is suggested that this type of review of the core curriculum be undertaken biennially.

The process described above would be educationally unproductive, however, if all attention were given the curriculum and the teachers were overlooked. A continuing program of in-service teacher training will contribute greatly to maintaining the technical currency of teachers of aviation mechanics. One means of keeping the teachers up to date will be to organize in-service teacher training workshops on a national level. Extensions of this service to other aviation mechanics instructors will augment the effectiveness of their instruction and enable them to present the most recently validated data on the essential technical and manipulative skills.

Efforts planned for the future at appropriate times include short experimental training programs using instructional materials that are designed to meet the levels of educational attainment identified in this study. These programs will include: training of selected aviation mechanic instructors in the use of instructional materials developed through the findings of this study; testing the innovated curriculum to determine the effectiveness of the specially designed instructional materials; and testing for significant differences of teaching effectiveness between instructors trained in the use of prepared materials and instructors who lack this special training.

Pilot programs for training aviation mechanics, based on the entire core curriculum, will be established at a later date. These programs will be conducted by teachers who will have been trained in the use of the new instructional materials directly applicable to the new curriculum. These pilot programs will be of sufficient duration to permit them to be evaluated by a comparison of a group of mechanics graduated from a program taught under the innovated curriculum and another group of mechanics graduated from other programs.

The goals presented herein can realistically be met and are well within the purview of all who are associated with the aviation industry. A continued cooperative interaction between the industry and the schools can significantly assist the future of aviation.

Appendix A

NATIONAL ADVISORY COMMITTEE

The National Advisory Committee is comprised of the following members:

B. B. Ashlock	Training Director, Airwork Corporation Millville, New Jersey
N. Birta	Principal, Aero Mechanics High School Detroit, Michigan
J. E. Christopher	General Aviation Specialist, Flight Standards Division, Federal Aviation Agency, Fort Worth, Texas
B. C. Draper*	Supervisor of Training, United Air Lines, Los Angeles International Airport Los Angeles, California
A. W. Elwell	Supervisory Examination Specialist, Maintenance Technical Standards Branch, Federal Aviation Agency Aeronautical Center, Oklahoma City, Oklahoma

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*Mr. Draper attended the second meeting of the National Advisory Committee at Purdue University, April 12-13, 1966, as a special advisory member in the area of aviation electronics.

J. M. Fisher	Vice-President, Pittsburgh Institute of Aeronautics, Pittsburgh, Pennsylvania
C. B. Gregg	Director, Technical Training and Qualifications, American Airlines, Maintenance and Engineering Center, Tulsa, Oklahoma
R. H. Madeira	President, Page Aircraft Maintenance, Inc., Dothan, Alabama
H. A. Palmer	Service Manager, Vroman Aviation, Inc., Midland, Texas
H. B. Pickering	Chief, Airmen and Schools Group, Maintenance Division, Federal Aviation Agency, Washington, D.C.
H. Rosen	Assistant Director of Research, Office of Research, United States Department of Labor, Washington, D.C.
C. W. Schaffer	Principal Maintenance Inspector, Federal Aviation Agency, General Aviation District Office, Allegheny County Airport, West Mifflin, Pennsylvania

J. J. Tordoff	Manager of Personnel Management, United Air Lines, San Francisco International Airport, San Francisco, California
A. Vai	Director of Aviation Maintenance Training, Northrop Institute of Technology, Inglewood, California
E. G. Willis	Chairman, Southern Region Repair Station Advisory Council, Jacksonville, Florida
F. Woehr	Principal, Aviation High School, Long Island City, New York

Appendix B

RESEARCH SURVEY ANALYSTS

The six research survey analysts and their respective areas of responsibility for conducting the national survey are listed here.

AREA I

Washington, Oregon, Utah, and Idaho	James W. Carlson Pullman, Washington

Mr. Carlson attended Washington State University where he majored in civil engineering, with additional study in advanced Air Force ROTC His experience includes ownership and operation of a construction contracting firm in Pullman, Washington.

AREA II

Texas, Oklahoma, Kansas, Colorado, and western Missouri	Stanley L. Moore Norman, Oklahoma

Mr. Moore received his degree in civil engineering from the University of Oklahoma where he was an assistant professor of engineering for many years.

AREA III

Minnesota, Iowa, Illinois, and eastern Missouri	William J. Schill Champaign, Illinois

Dr. Schill received his doctorate from the University of California, Los Angeles, and is now associated with the Department of Vocational and Technical Education, University of Illinois.

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AREA IV

North Carolina, South Carolina, Georgia, and Florida	Capt. Ira W. Brown, USN (ret.) Virginia Beach, Virginia

Capt. Brown has an extensive background in military aviation as a pilot and in aircraft testing and aircraft maintenance engineering.

AREA V

Maryland, Michigan, Ohio, Pennsylvania, and Washington, D.C.	Cdr. John N. White, USN (ret.) Hillcrest Heights, Maryland

Cdr. White is an experienced military pilot who has been associated with aircraft operational and maintenance activities for 22 years.

AREA VI

New Jersey, Massachusetts, New York, and Connecticut	Lcdr. Roger M. Turner, USN (ret.) Virginia Beach, Virginia

Lcdr. Turner has had more than 30 years experience in aviation maintenance as a mechanic and as a supervisor and director of military maintenance activities.

Appendix C

RESPONDING COMPANIES

CALIFORNIA

Bakersfield

Buchner's Flying Service
Meadows Field

Del's Air Service
Minter Field

Inland Crop Dusters, Inc.
Minter Field

Vern's Wing Shop
Minter Field

Burbank

Comet Copters
Lockheed Air Terminal

Monark Flight Service
Lockheed Air Terminal

Pacific Airmotive Corp.
Lockheed Air Terminal

Potter Aircraft Service, Inc.
Lockheed Air Terminal

Qualitron Aero, Inc.
Lockheed Air Terminal

Richfield Oil Co.
Lockheed Air Terminal

Sky Roamers Air Travel, Inc.
Lockheed Air Terminal

Chico

Chico Aviation Service
Chico Municipal Airport

Chico (continued)

Al Sos Aviation
Rt. 3, Box 464 Chico Ranchero

Clarksburg

Air Repair
Borges-Clarksburg Airport

Fresno

Air-Oasis Co.
Chandler Municipal Airport

Howard Winters Co.
Fresno Air Terminal

Norsigian Bros.
Fresno Air Terminal

Skyway Service
Chandler Municipal Airport

Glendale

Grand Central Aircraft Co.
Box 3157

Hagelin Aircraft Motors, Inc.
933 Air Way Drive

Hawthorne

Progressive Air Service, Inc.
Hawthorne Airport

Bates Aviation, Inc.
Hawthorne Airport

CALIFORNIA (continued)

Long Beach

Aircraft Associates
Long Beach Airport

Air Oasis Co.
Long Beach Airport

Aztec Aircraft Sales, Inc.
Long Beach Airport

Beach-Air, Inc.
Long Beach Airport

Belmont Aviation Corp.
Long Beach Airport

Scott Aero Services, Inc.
Long Beach Airport

Los Angeles

AiResearch Aviation Service Co.
Los Angeles International Airport

American Airlines
Los Angeles International Airport

Continental Air Lines, Inc.
Los Angeles International Airport

Pan American World Airways
Los Angeles International Airport

Trans World Airlines
Los Angeles International Airport

United Air Lines
Los Angeles International Airport

Western Air Lines
Los Angeles International Airport

Modesto

Pacific Aircraft Service
Modesto City-County Airport

Oakland

California Aviation Service, Inc.
Oakland International Airport

Golden Gate Aviation, Inc.
Oakland International Airport

World Airways
Oakland International Airport

Ontario

Aerojet General Flight Operations
Ontario International Airport

Zantop Air Transport
Ontario International Airport

Pacoima

Volitan Aviation, Inc.
Pacoima Airport

W. H. Coffin Air Service, Inc.
Pacoima Airport

Palo Alto

Hiller Aircraft Co.
Palo Alto

Oceanside

Palomar Aviation
Palomar Airport

Pomona

Brackett Field Aircraft Service
Brackett Field

Northside Aircraft Maintenance
Brackett Field

CALIFORNIA (continued)

Rio Vista

Westare Service
P. O. Box 745

Riverside

Air Oasis Co.
Riverside

Sacramento

Capitol Sky Park, Inc.
Sacramento Municipal Airport

Cartwright Aerial Surveys, Inc.
Sacramento Municipal Airport

Jensen Field
Sacramento

Patterson Aircraft Co.
Sacramento Municipal Airport

Rotorcraft Industries, Inc.
Sacramento Municipal Airport

State of California
Department of Fish and Game
Sacramento Municipal Airport

San Carlos

Custom-Air
San Carlos Airport

San Diego

Air Oasis Co.
Lindbergh Field

Carson Airplane Service
Santee

Pacific Southwest Airlines
3100 Goddard Way

San Diego (continued)

Spider's Aircraft Service
Montgomery Field

San Fernando

Deb's Aircraft and Engine Service
1065 Arroyo

Ryan Air Service
San Fernando

San Francisco

Butler Aviation-San Francisco, Inc.
San Francisco International Airport

Flying Tiger Line, Inc.
San Francisco International Airport

Pacific Air Lines
San Francisco International Airport

Pan American World Airways
San Francisco International Airport

Rick Helicopters, Inc.
San Francisco International Airport

Slick Airways, Inc.
San Francisco International Airport

United Air Lines
Maintenance Base
Line Service Center
San Francisco International Airport

San Jose

FMC Corporation
San Jose

Gee Bee Aero
San Jose

Lockheed Aircraft Service Company
San Jose Municipal Airport

CALIFORNIA (continued)

San Jose (continued)

San Jose Aircraft Service
San Jose Municipal Airport

Wright Brothers, Inc.
San Jose Municipal Airport

San Mateo

Nystrom Aviation, Inc.
San Mateo County Airport

Santa Monica

Bacon Aircraft Co.
Santa Monica Airport

Conard Aviation Services
Santa Monica Airport

Gunnell Aviation, Inc.
Santa Monica Airport

Mox-Air
Santa Monica Airport

Santa Monica Aviation, Inc.
Santa Monica Airport

Santa Monica Flyers
Santa Monica Airport

Stockton

Bridgeford Flying Service
Stockton Metropolitan Airport

Werner's Aero Service
Stockton Metropolitan Airport

Torrance

Acme Aircraft Co.
Torrance Airport

Mercury General American Corporation
Torrance

Nagle Aircraft Sales, Inc.
Torrance

Tulare

Johnston Aircraft Service
Tulare Air Park

Tulare Aircraft Service
Tulare Air Park

Van Nuys

Air Travelers, Inc.
Van Nuys Airport

Great Western Aviation of Van Nuys
Van Nuys Airport

Planeservice, Inc.
Van Nuys Airport

Valley Pilots Flying Service
Van Nuys Airport

COLORADO

Aurora

Skyranch Aviation
Skyranch Airport - P. O. Box 458

Broomfield

Kensair Corporation
Jefferson County Airport

Colorado Springs

Beeline Aviation, Inc.
Peterson Field - P. O. Box 7885

Denver

Aircraft Radio & Accessory Company, Inc.
Stapleton Airfield

Combs Aircraft, Inc.
Stapleton Airfield, Hangar #7

Continental Airlines, Inc.
Stapleton Airfield

Denver (continued)

Frontier Airlines, Inc.
Stapleton Airfield

United Airlines, Inc.
Stapleton Airfield

Western Air Lines, Inc.
Stapleton Airfield, Hangar #4

La Junta

Todd Flying Service
P. O. Box 605

Pueblo

Pueblo Aircraft Service
Airport Box 149

CONNECTICUT

New Haven

NHA Radio and Maintenance
Tweed New Haven Airport

New London

Pilgrim Aviation & Airlines, Inc.
Box 1743

Windsor Locks

Air Kaman, Inc.
Bradley Field

DELAWARE

Wilmington

Atlantic Aviation Corporation
Wilmington Division

WASHINGTON, D. C.

American Airlines, Inc.
Washington National Airport

Delta Air Lines, Inc.
Washington National Airport

Northwest Air Lines
Washington National Airport

Piedmont Airlines
Washington National Airport

Trans World Airlines, Inc.
Washington National Airport

United Air Lines, Inc.
Washington National Airport

FLORIDA

Daytona Beach

Embry-Riddle Aeronautical Institute
P. O. Box 2411

Fort Lauderdale

Mackey Airlines, Inc.
International Airport
500 S. W. 34th Street

Riley Aeronautics Corporation
2100 N. W. 50th Street
Fort Lauderdale Executive Airport

Jacksonville

East Coast Flying Service
Imeson Field

Miami

Aero Facilities Corporation
P. O. Box 245

Airtech Service, Inc.
International Airport
P. O. Box 48-516

American Airmotive Corporation
International Airport

Eastern Air Lines, Inc.
Miami International Airport

Miami (continued)

National Airlines, Inc.
P. O. Box 2055
Airport Mail Facility

Pan American World Airways
36th Street

Southern Air Transport, Inc.
International Airport
P. O. Box 48-1266

Opa Locka

Dumod Corporation
Opa Locka Airport
P. O. Box 425

Engine Air, Inc.
Building 147
Wright Road, Opa Locka Airport

Tursair Executive Aircraft, Inc.
Hangar #101, Opa Locka Airport
P. O. Box 85

Orlando

Showalter Flying Service, Inc.
Municipal Airport

Southern Airways of Florida
Municipal Airport
P. O. Box 20174

FLORIDA (continued)

Sebring

Eighth Air Depot, Inc.
Sebring Air Terminal

Tampa

Aircraft Propeller, Inc.
4021 W. Cayuga Street

West Palm Beach

Butler Aviation
Hangar #475, Duncan Avenue
International Airport

GEORGIA

Atlanta

Delta Air Lines, Inc.
Atlanta Airport

Southern Airways Company
Atlanta Airport

Atlanta (continued)

United Air Lines, Inc.
Atlanta Airport

Macon

Associated Airmotive, Inc.
Municipal Airport, Cochran Field

IDAHO

Boise

Aircraft Service & Repair Company
2410 Sunrise Rim Road

Morrison-Knudsen Company, Inc.
Aviation Department
Gowen Field - P. O. Box 7808

Sparks Flying Service
Municipal Airport

Burley

Magic Valley Aviation
Box 824

Idaho Falls

Idaho Aviation Center, Inc.
Box 498

Lewiston

Hillcrest Aircraft Company
Box 405

Nampa

Clarks Flying Service
Box 56

Twin Falls

Reeder Flying Service
Municipal Airport

ILLINOIS

Chicago

Helicopter Air Lift, Inc.
5245 W. 55th Street

Trans World Airlines, Inc.
O'Hare International Airport
P. O. Box 8787

United Airlines
Elk Grove Village

Crystal Lake

Executive Aircraft Maintenance Corp.
Crystal Lake Airport

East Alton

Walston Aviation, Inc.
Civic Memorial Airport

East St. Louis

Parks College of Aeronautical Technology
of St. Louis University
Parks Airport

Elgin

B & M Aircraft Corporation
Elgin Airport

Midlothian

Howell Flying Service
13202 S. Circus

Northbrook

Aircraft Propeller Sales & Service
Sky Harbor Airport

Prairie View

Whirlwind Propeller Service, Inc.
Chicagoland Airport
Box 246-A

Rockford

Hartzog-Schneck Aviation, Inc.
Greater Rockford Airport

Sundstrand Aviation
Division-Sundstrand Corporation
2421 11th Street

Woodward Governor Company
5001 N. Second Street

Springfield

Capitol Aviation, Inc.
Capital Airport

IOWA

Des Moines

Des Moines Flying Service, Inc.
Municipal Airport

KANSAS

Dodge City

Mahon's Boot Hill Flying Service
Municipal Airport - Box 194

Kansas City

Aircraft and Industrial Services
3041 Fairfax Road

Topeka Aircraft Sales and Service
3251 Fairfax Road
Fairfax Airport

Wichita

Beech Aircraft Corporation
9709 E. Central

Wichita (continued)

Lear Jet Corporation
Municipal Airport
Box 28

Midwest Piper Sales, Inc.
Box 2667
Munger Station

Standard Precision, Inc.
Div. of E.C.I., St. Petersburg, Fla.
4105 W. Pawnee

United Airplane Sales, Inc.
Municipal Airport

Yingling Aircraft, Inc.
P. O. Box 1162
Municipal Airport

MARYLAND

Baltimore

Bendix Corporation
Friendship International Airport

Butler Aviation, Inc.
Friendship International Airport

Chesapeake & Potomac Airway
Friendship International Airport

Baltimore (continued)

Delta Airlines, Inc.
Friendship International Airport

Marshall-Air
Friendship International Airport
2300 Dorsey Road

Pan American World Airways
Friendship International Airport

MASSACHUSETTS

Beverly

Revere Aviation, Inc.
Beverly Airport

Boston

Northeast Airlines, Inc.
Logan International Airport

MASSACHUSETTS (continued)

East Boston

Butler Aviation-Boston Inc.
Logan Airport

Great Barrington

Berkshire Aviation Enterprises, Inc.

Mansfield

Carleton-Whitney Aero Service, Inc.
Municipal Airport

North Adams

Mohawk Valley Aviation Company, Inc.
Harriman Airport

Worcester

Atlantic Aviation
Municipal Airport

MICHIGAN

Adrian

Prentice Aircraft, Inc.
Adrian City Airport

Detroit

Helicopter Airways Service, Inc.
Metropolitan Airport

Freeland

Air-Flite & Serv-A-Plane, Inc.
Tri-City Airport

Grand Rapids

Northern Air Service, Inc.
Kent County Airport

Inkster

American Airlines, Inc.
Detroit-Metropolitan Airport

Pontiac

Aerodynamics, Inc.
Municipal Airport

Michigan Aviation Company
6150 Highland Road
Municipal Airport

Sparta

Sparta Aviation Service
Sparta Airport

Three Rivers

Ward Aero, Inc.
Haines Airport
Box 219

Ypsilanti

United Air Lines, Inc.
Willow Run Airport

MINNESOTA

Minneapolis

Minnesota Airmotive
Division-F. H. Peavey & Company
Wold-Chamberlain Field

Northwest Airlines, Inc.
Minneapolis-St. Paul International Airport

St. Paul

Minnesota Mining & Mfg. Company
Aviation Department
South Riverside Hangar
Downtown Airport, Holman Field

MISSOURI

Kansas City

Executive Aircraft Company
Municipal Airport

Kansas City Flying Service &
Air College, Inc.
601 Lou Holland Drive

Trans World Airlines, Inc.
Mid-Continent International Airport

Perryville

Beldex Corporation
Division of Remmert-Werner
Chester-Perryville Airport

St. Louis

Interstate Airmotive, Inc.
Lambert Field

Ozark Air Lines, Inc.
Lambert Field

NEW JERSEY

Linden

MATCO, Corporation
Linden Airport

Millville

Airwork Corporation
Municipal Airport

Morristown

Continental Can Company, Inc.
Air Transport Department
Box 791

Newark

Newark Air Service, Inc.
Hangar #12 - Newark Airport

Newton

The Aeroflex Corporation
Aeroflex-Andover Field
Rd. #1, Box 411

South Hackensack

National Distillers & Chemical Corp.
Air Transport Division, RS 1166

Teterboro

Teterboro Aircraft Service
Teterboro Airport
401 Industrial Avenue

Atlantic Aviation Corporation
Teterboro Airport

NEW YORK

Albany

New York State Conservation Department
Aviation Division
Albany County Airport

Binghamton

Broome County Aviation, Inc.
Box 904
Broome County Airport

Buffalo

Buffalo Aeronautical Corporation
Buffalo Airport

Buffalo Air-Park, Inc.
4500 Clinton Street

Elmira

Schweizer Aircraft Corporation
Chemung County Airport
P. O. Box 147

Flushing

American Airlines, Inc.
LaGuardia International Airport

Butler Aviation-LaGuardia
Hangar #7 - LaGuardia Airport

New York Airways, Inc.
LaGuardia Airport - P. O. Box 426

Speed's Flying Service, Inc.
23-11 Linden Street
Flushing Airport

Horseheads

Elmira Aeronautical Corporation
3330 Sing Sing Road

Jamaica

Lockheed Aircraft Service Company
A Division-Lockheed Corporation
John F. Kennedy International Airport

Pan American World Airways
John F. Kennedy International Airport

Seaboard World Airlines, Inc.
John F. Kennedy International Airport

Trans World Airlines, Inc.
John F. Kennedy International Airport

Lawrence L. I.

Airengines, Inc.
25 Buena Vista Avenue

Mattituck

Mattituck Airbase, Inc.
Mattituck Airport

Rochester

Eastman Kodak Company
1705 Scottsville Road

Page Airways, Inc.
Rochester Airport - Box 1132

Ronkonkoma

Aero Trades, Inc.
MacArthur Airport

Long Island Airways, Inc.
MacArthur Airport - Box 248

Syracuse

Flight Maintenance Inc.
Hancock Airport

NEW YORK (continued)

Syracuse (continued)

Franklin Engine Company, Inc.
Liverpool Road

Utica

Mohawk Airlines, Inc.
Oneida County Airport

White Plains

American Can Company
Hangar E, Westchester County Airport

White Plains (continued)

General Electric
Air Transport Operation
Hangar E, Westchester County Airport

Johns-Manville Corporation
Westchester County Airport

Union Carbide Corporation
Aviation Department, Hangar D, Bay 2
Westchester County Airport

NORTH CAROLINA

Charlotte

Cannon Aircraft Sales & Service, Inc.
Douglas Municipal Airport - Box 968

Charlotte Aircraft Engineering, Inc.
Delta Air Base - P. O. Box 9127

Morrisville

Raleigh-Durham Aviation, Inc.
Raleigh-Durham Airport - Box 200

Winston-Salem

Piedmont Aviation, Inc.
Smith Reynolds Airport

OHIO

Cincinnati

American Airlines, Inc.
Greater Cincinnati Airport

Cincinnati Aircraft, Inc.
Hangar #2 - Lunken Airport

T. W. Smith Aircraft, Inc.
Blue Ash Airport
4490 Cooper Road

Cleveland

Aircraft Service, Inc
Cleveland-Hopkins Airport Hangar #N-9

Cleveland (continued)

American Airlines, Inc.
Cleveland-Hopkins Airport

General Airmotive Corporation
Cleveland-Hopkins Airport

Sundorph Aeronautical Corporation
Cleveland-Hopkins Airport

United Air Lines, Inc.
Cleveland-Hopkins Airport

Columbus

Clydesdale Aircraft Corporation
3850 E. Fifth Avenue

OHIO (continued)

Columbus (continued)

Executive Jet Aviation
Port Columbus Airport

Lane Aviation Corporation
Port Columbus Municipal Airport
Lane Memorial Hangar

Defiance

Zelair Corporation
Box 462
Bryan-Defiance Memorial Airport

Findlay

Marathon Oil Company
Aviation Division, Findlay Airport

Mansfield

Richland Aviation, Inc.
Municipal Airport

New Philadelphia

Tuscarawas County Aviation, Inc.
Municipal Airport
1834 E. High Ext.

Swanton

National Flight Service, Inc.
R. R. #4, Box 302

Toledo

Continental Aviation &
Engineering Corp.
1330 Laskey Road

Vandalia

Ohio Aviation Company
P. O. Box 398

Skyways, Inc.
Dayton Municipal Airport - Box 175

West Carrollton

Southern Ohio Aviation
P. O. Box 97

OKLAHOMA

Ardmore

American Flyers, Inc.
Ardmore Industrial Air Park

Bethany

Aero-Commander
Division Rockwell Standard Corporation

Aircraft Engine Service, Inc.
5414 N. Rockwell Avenue

Bethany (continued)

United Airplane Sales of
Oklahoma, Inc.
Wiley Post Airport
Hangar # 4

Duncan

Haliburton Company

OKLAHOMA (continued)

El Reno

El Reno Aviation, Inc.
Municipal Airport
P. O. Box 760

Oklahoma City

Aircraftsmen, Inc.
Will Rogers Field
P. O. Box 82516

Catlin Aviation Company
Will Rogers Field
P. O. Box 82398

Tulsa

American Airlines, Inc.
Maintenance & Engineering Center
Municipal Airport

Spartan Aircraft Company
Aviation Service Division
Municipal Airport

Yukon

Page Airmotive, Inc.
Cimarron Field
P. O. Box 12099

OREGON

Albany

Flyways, Inc.
3520 Knox Butte Road

Corvallis

Corvallis Aero Service, Inc.
Box 531

Hillsboro

Hillsboro Aviation
26225 N. W. Cornell Road

Inman Aviation, Inc.
1105 S. E. 36th Avenue
P. O. Box 66

Pendleton

Pendleton Airmotive, Inc.
Municipal Airport
Box 623

Portland

Flightcraft, Inc.
7505 N. E. Airport Way

Pan American World Airways
Portland International Airport

United Air Lines, Inc.
7000 N. E. Airport Way

Salem

Salem Aviation Inc.
3450 25th Street S. E.

Troutdale

Western Skyways, Inc.
Portland-Troutdale Airport

PENNSYLVANIA

Allentown

Reading Aviation Service, Inc.
A. B. E. Airport

Bethlehem

Bethlehem Steel Company
Aviation Services
A. B. E. Airport

Butler

Scholter Aviation Company, Inc.
475 Airport Road

Clarks Summit

Scranton Airways
Municipal Airport
Rd. # 1

Connellsville

The Lance Call Company, Inc.
Connellsville Airport
P. O. Box 754

Dravosburg

Beckett Aviation Flight Training
Allegheny County Airport

Gulf Oil Corporation
Allegheny County Airport

Erie

Erie Airways, Inc.
Port Erie Airport

Harrisburg

Lear Siegler Services, Inc.
Eastern Service Facility
6700 Allentown Boulevard

Kutztown

Kutztown Aviation Service, Inc.
Kutztown Airport

Lancaster

Sensenich Corporation
Box 1168

Latrobe

Latrobe Aviation, Inc.
Tri-City Municipal Airport
P. O. Box 150

Martinsburg

Penn-Air Inc.
P. O. Box 368

New Cumberland

L. B. Smith Aircraft Corp. of
Pennsylvania
Box 264
Har-York State Airport

Philadelphia

Aero Service Corporation
4219 Van Kirk Street

Atlantic Aviation Service, Inc.
P. O. Box 5138
International Airport

Delaware Aviation Inc.
North Philadelphia Airport

United Air Lines, Inc.
Philadelphia International Airport

Wings Inc.
Wings Field

PENNSYLVANIA (continued)

Pittsburgh

Alcoa Corporation of America
Allegheny County Airport

United Air Lines, Inc.
Greater Pittsburgh Airport
Terminal Building

Reading

Reading Aviation Service, Inc.
Box 1201
Municipal Airport

Renfrew

Defoggi Aviation Service
Rd. #1

Washington

Tri-State Aviation, Inc.
P. O. Box 238

West Mifflin

Air Exec. Inc.
Allegheny County Airport

National Steel Corporation
Allegheny County Airport

Williamsport

Lycoming Division-Avco Corporation
652 Oliver Street

Willow Grove

Kellett Aircraft Corporation
Box 35

SOUTH CAROLINA

Charleston

Hawthorne Aviation
Municipal Airport
P. O. Box 10005

Greenville

Brannon's Aero Service, Inc.
Box 871

Greer

Stevens Aviation, Inc.
Greenville-Spartanburg Airport
P. O. Box 589

West Columbia

H & H Aviation
P. O. Box 348

TEXAS

Abilene

Flite Maintenance
Rt. #2, Box 508

Addison

Brown Aero Corporation
P. O. Box 8

TEXAS (continued)

Arlington

Greater Arlington Airways
P. O. Box 1308
Arlington Municipal Airport

Austin

Browning Aerial Service
P. O. Box 609

Ragsdale Aviation, Inc.
1801 East 51st Street

Big Spring

Big Spring Aero Repair
Route #1, Box 144C

Dallas

Aerodyne Engineering Corporation
3300 Love Field Drive

Aero-Systems, Inc.
P. O. Box 20478

American Airlines, Inc.
Love Field

Braniff Airways, Inc.
Love Field

Dallas Aero Service, Inc.
3300 Love Field Drive
P. O. Box 35505

Delta Air Lines, Inc.
7201 Lemmon Avenue
Love Field

Executive Aircraft Service, Inc.
Redbird Airport

Modern Aero Sales, Inc.
Redbird Airport

Dallas (continued)

Mustang Aviation, Inc.
6911 Lemmon Avenue
Love Field

Southwest Airmotive Company
8800 Lemmon Avenue

Trans-Texas Airways, Inc.
Love Field

Fort Worth

Aircraft & Airport Services, Inc.
Greater Southwest Int'l.Airport

Broadie's Aircraft & Engine Service
Meacham Field

Central Airlines, Inc.
Greater Southwest Int'l.Airport

Continental Copters, Inc.
Box 13284

Helix Air Transports, Inc.
Division of M. H. Spinks
Enterprises, Inc.
P. O. Box 11099

Inter-American Modification Center
Meacham Field

Worth Aeronautics
Meacham Field

Houston

Air Center Maintenance
7700 Airport Blvd.

Aircraft Engines, Inc.
9041 Wingtip

Continental Oil Company
Aviation Department
8915 Randolph Road

TEXAS (continued)

Houston (continued)

Cruse Aviation, Inc.
8501 Telephone Road

Hinkle Aircraft, Inc.
International Airport
8450 Lockheed

Houston Beechcraft, Inc.
9011 Randolph Road

Charles A. Morse Company
International Airport
9046 Randolph

Precision Aeromotive Corporation
International Airport

The Superior Oil Company
8901 Telephone Road

Trans-Texas Airways, Inc.
International Airport
P. O. Box 60188

Lubbock

Aero Communications
Rt. #3, Box 201-D

Horton Aero Service
915 Kent

Lubbock Beechcraft, Inc.
Rt. #3, Box 194P

Midland

Vroman Aviation, Inc.
P. O. Box 6257

San Antonio

All American Maintenance Inc.
9103 Wetmore Road

Business Aircraft Corporation
447 W. Terminal Drive
International Airport

Chrome Plate, Inc.
9503 Middlex

Gen-Aero Inc.
260 E. Terminal Drive
International Airport
Box 16217

Nayak Aviation Corporation
206 E. Terminal Drive

San Antonio Propeller Service
130 S. Terminal Drive
International Airport

Tex-Sun Beechcraft South, Inc.
International Airport
P. O. Box 16248

Reuben E. Weiss
Hangar #8
South Terminal Drive
International Airport

Waco

Waco Aviation
Rt. #10
Box 173T

UTAH

Ogden

Southwestern Skyways, Inc. of Utah
3909 Airport Road

Salt Lake City

Thompson Flying Service of Salt Lake
Airport #1

WASHINGTON

Everett

Precision Air-Motive, Inc.
P. O. Box 2127

Thunderbird Aero Enterprises, Inc.
Snohomish County Airport

Willard Flying Service
P. O. Box 172
Paine Field

Gig Harbor

TideAir, Inc.
Rt. #2, Box 2194B
Tacoma International Airport

Issaquah

John M. Gallagher
237 Maple Lane

Kelso

Davis Air Service, Inc.
2222 South Pacific

Kent

Crest Aero
Rt. #1, Box 811

Olympia

Capital Airways
Rt. #5, Box 63

Renton

The Boeing Company
Transport Division
Box 707

Renton (continued)

Shupe Flying Service
P. O. Box 3355
Municipal Airport

Richland

Richland Flying Service Inc.
P. O. Box 611

Seattle

Aero Copters, Inc.
8333 Perimeter Road
Boeing Field

Alaska Airlines, Inc.
Seattle-Tacoma Int'l. Airport

Pacific Airmotive Corporation
Seattle Branch
7097 Perimeter Road

Pacific Northern Air Lines, Inc.
Seattle-Tacoma Int'l. Airport

State of Washington
Department of Natural Resources
20234 7th Place South

United Air Lines, Inc.
Seattle-Tacoma Int'l. Airport

Washington Aircraft &
Transport Corp.
7170 Perimeter Road South
Boeing Field

West Coast Airlines, Inc.
Boeing Field

Spokane

Mamer-Shreck Air Transport
Box 272
Parkwater Station

WASHINGTON (continued)

Spokane (continued)

Mifflin Aircraft
E. 6507 Rutter
Felts Field

Price Piper, Inc.
E. 5829 Rutter Avenue
Felts Field

Walla Walla

Blue Mountain Aviation & Dusting Corp.
Rt. #4
City County Airport

Wenatchee

WenAirCo.
Aircraft Service
Box 1160

Yakima

Helicopter Service
2108 W. Washington Avenue
Yakima Airport

Noland-Decoto Flying Service, Inc.
Box 431
Municipal Airport

Northwest Air Power
2108 W. Washington
Yakima Airport

By their request, the names of four additional companies are not listed here.

Responding airline companies having both overhaul and line facilities at the same station are listed only once in Appendix C. However, the statistics for the overhaul and line facilities for such companies are shown separately in Figs. 2 and 3 in the "Action" section of the report.

Phase II

A National Study of the

AVIATION MECHANICS OCCUPATION

Interim Report

David Allen • William K. Bowers • Alvin Gorenbein • John M. Meyer

A Cooperative Study between the
Division of Vocational Education,
University of California, Los Angeles;
Bureau of Industrial Education,
California State Department of Education; and
U.S. Office of Education
1968

INTERIM REPORT

Project No. 5-0189

Vocational and Technical Education Contract OE-o-85-043

A National Study of the
AVIATION MECHANICS OCCUPATION
Phase II

DAVID ALLEN . WILLIAM K. BOWERS . ALVIN GORENBEIN . JOHN M. MEYER

A cooperative study between the Division of Vocational Education, University of California, Los Angeles; Bureau of Industrial Education, California State Department of Education; and the U. S. Office of Education.

UNIVERSITY OF CALIFORNIA, LOS ANGELES
March, 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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A NATIONAL STUDY OF THE AVIATION MECHANICS OCCUPATION, PHASE II

INTRODUCTION

This report describes the planning, implementation, results, and implications of a controlled educational experiment involving aviation mechanic teachers and students. As Phase II of A National Study of the Aviation Mechanics Occupation, it focuses on a pilot program in curriculum development based on the findings of Phase I of the National Study.

Phase I analyzed the on-the-job activities of thousands of aviation mechanics and identified a common core curriculum for their training; it also specified depth of instruction for each of the 507 individual tasks in the aviation mechanics occupation.

Phase II, the present project, implements the results of the Phase I study by applying its findings and recommendations to the development and use of a new curriculum for one subject in the aviation mechanic's occupational preparation--Aircraft Hydraulics. The design of the experimental program is based on the assumption that instructors employing specially designed instructional materials in whose use they have had training and practice will teach their students in greater depth and with better retention than would be achieved when a control subject is taught to the same students using the teacher's customary methods and materials.

The educational experiment reported here was funded by the U. S. Office of Education under the Vocational Education Act of 1963, Section 4(c), Vocational and Technical Education Contract OE-6-85-043. Initiated in 1965, the National Study of the Aviation Mechanics Occupation is a cooperative activity of the Division of Vocational Education of the University of California, Los Angeles, the Bureau of Industrial Education of the California State Department of Education, and the U. S. Office of Education.

THE PROBLEM

The need for instructional planning always has been apparent in education; it has constantly been recognized as one of the most important parts of the teaching assignment. The effectiveness of such planning often ranges from the very weak to the very strong, depending on the many varied factors acting in concert with the teacher in the classroom.

Vocational education is neither unique nor in isolation from other disciplines when the effects of instructional planning are considered. Aviation mechanic schools always have been an integral part of vocational education and, like other schools, vary in the strength of their instructional programs.

The purpose of this study was to determine whether subject matter in the aviation mechanic's curriculum could be learned as well under an instructional system that programs the teacher and his instruction to the student's learning progress, as under the traditional instructional methods now in use in aviation schools. Specifically, the problem resolved into comparing the relationship between: (1) an instructional system having predetermined student performance goals, in relation to current instructional systems that use traditional instructional objectives; (2) an instructional system that provides continuous feedback to the teacher as he instructs as to how well learning is being achieved, in relation to traditional instructional systems that have no planned provisions for feedback during teaching; and (3) an instructional system that provides student workbooks utilizing "partial notes" that are coordinated with an instructor's guide, to the traditional instructional systems that make no special provisions for organized note-taking by the student.

Problems that frequently arise in developing instruction are the failure to properly identify the desired learning achievements, and the inability to describe in detail the conditions and limitations of what is to be taught. Instructional objectives, in many cases, do not reflect the purposes of detailed instruction in the classroom and fail to set the parameters for instructional organization, presentation, and evaluation. Teachers need assistance in developing abilities to guide each of their students in meaningful learning activities. Teachers must avoid overteaching in unimportant instructional areas and underteaching in important instructional areas. They must make more effective and meaningful use of all classroom and laboratory instructional time. In addition, they must learn how to test continually to determine how well instructional content is being learned at the time teaching is occurring.

In developing the plan for the educational experiment reported here, it was assumed that the depth to which the student would learn and his ability to retain this knowledge would be proportional to the extent of his involvement in the instructional process. The first assumption, therefore, was stated as follows: When student performance goals are identified, when levels of instruction have been realistically organized, and when evaluation of student progress has been programmed in the form of frequent feedback between student and teacher, then the amount of learning would increase and retention of knowledge would improve.

The second assumption was based on the belief that an increase in instructional effectiveness could be realized if and when teachers have been properly trained in the presentation of specially designed instructional materials. The design of the experimental program reported here was based on the assumption that the students of teachers who are given specially designed instructional materials and training in the use of these materials would learn more effectively and achieve greater retention than would result when the same students were taught by the same instructor using his customary teaching materials and methods.

DEFINITIONS OF TERMS

A number of terms have been derived from the research work performed during this phase as well as during the survey phase of the Study. These are presented below:

Student Performance Goals

This term was developed to assist instructors to better understand the meaning of behavioral objectives. Student performance goals describe the sought-for response or behavior of the student at the conclusion of a segment of instruction; they provide a way for the instructor to recognize the point at which predetermined observable changes have occurred in the student's performance. These goals are established by those individuals who are responsible for curriculum design, and may be expressed in terms of how a student performs.

Student performance goals are statements in a curriculum that are characterized by three items of information: (1) what the student will be able to do; (2) how he is going to do it; and (3) how well he must do it to be considered successful.

Levels of Instruction

Four levels of instruction, 1 through 4, were established during Phase I of the National Study of the Aviation Mechanics Occupation. These range from the ability to follow directions (Level 1) to in-depth analysis of the subject (Level 4). These levels indicate the depth to which any given subject should be taught for most efficient use of instruction and class time as correlated with the demands of the occupation. Levels of instruction establish the standard for learning success measurement described in the student performance goals.

Each level of instruction has been given an equivalent testing level,--Level 1--Knowledge, Level 2--Comprehension, Level 3--Application, and Level 4--Analysis/Synthesis--to determine whether the specified teaching levels have been achieved.

Common Core Curriculum

A common core curriculum consists of occupational tasks that are basic to all aviation mechanic students. The common core curriculum lists the tasks and identifies the teaching and testing levels appropriate to each, as delineated in the survey phase of the National Study and adjusted by the recommendations of the National Advisory Committee. The common core curriculum can be modified by each school to meet the specialized requirements of local industry.

Instructional Unit

An instructional unit is a logical subdivision of a block of instruction, such as Aircraft Hydraulics. It normally consists of several segments identified through task analysis. An instructional unit is an entity that is identified by its homogeneous content. It is not determined by intervals of time. It is that part of the instruction that focuses upon a central theme, such as Basic Aircraft Hydraulic Systems. For the purposes of this study, the block of instruction for the experimental curriculum (Aircraft Hydraulics) was divided into five instructional units.

Unit Segment

Unit segments were delineated by dividing each instructional unit into segments which have tasks identified with student performance goals. Each unit segment has its own student performance goals, provisions for the presentation of key instructional points, and a listing of feedback activities for student participation through which the teacher can determine how his students are meeting the requirements specified in the student performance goals for the particular unit segment.

PREVIOUS STUDIES

A comprehensive review was made of studies of teaching experiments having points of similarity to the study reported here. The review included a search of appropriate journals, bulletins, reports, and publications. This search uncovered a number of studies whose purposes and objectives included partial similarities to those of the study reported here.

None of the studies, though similar in some details, seems to have any significant bearing on the present study because none was constructed with the various in-depth criteria established for this experiment. Moreover, the studies investigated did not include specialized teacher training in the use of specially prepared teacher and student texts and materials, including visual aids, nor the use of a complete package comprising immediate feedback, student performance goals, and student testing and retention-testing, as was done in this experiment. Also contributing to the differences between the controlled educational experiment and analogous projects was the fact that the complete package developed for the former was applied to both skill and technical training and instruction of students, rather than to either skill or technical training alone.

DESIGN OF THE EXPERIMENT

In attempting to fulfill the requirements of a modern self-contained experiment, randomization and replication were utilized as fully as possible. Randomization permitted statistical analysis for the testing of the hypotheses. The claim for randomization in this experiment was based upon the fact that the samples of students were not influenced by the Research Staff in any way regarding their selection, thus allowing the normal forces acting upon this population to result in completely typical samples of the student population registered in aviation mechanic classes.

Replication provided a method for estimating experimental error. It is necessary to have at least two replications in estimating experimental error variance. This was obtained by having more than two samples to which the same treatment was administered.

Scientific experimentation is concerned with the empirical testing of hypotheses. In order to place the burden of showing any significant difference between the methods of instruction directly upon the evidence obtained from them, the following null hypotheses were adopted: (1) there is no difference between subject matter achievement of students who undergo instruction having predetermined student performance goals, and instruction having traditional instructional objectives; (2) there is no difference between subject matter achievement among students who undergo instruction containing continuous feedback, and instruction having no planned provisions for feedback; and (3) there is no difference between subject matter achievement of students who use workbooks having "partial notes" that are coordinated with an instructor's guide, and instruction having no special provisions for organized note-taking by the students.

Due to the natural limitations on the sizes of the samples of students investigated, a five percent level of significance was adopted; thus, to reject the null hypothesis that any observed differences in samples' means would be due to chance factors rather than to other causes, the observed differences would have to be large enough to be attributable to chance factors in five percent or less trials only.

A bi-variate inversion method was used to test the effectiveness of the experimental subject curriculum. Following the randomized selection of 12 aviation mechanic schools throughout the United States, the sub-populations were further organized into two treatment groups (identified as Group A and Group B, respectively), for the purpose of inverting the sequential order of the experiment between groups. The experimental design required that two subjects, an experimental subject (Aircraft Hydraulics "subject X")and a control subject ("subject C"), be presented to the same students by the same teacher, in 60 clock hours of instruction for each subject.

The Research Staff developed the experimental curriculum, along with specified teaching techniques, to cover a two-week block of instruction. Teaching with the experimental block of instruction was preceded in both groups by a one-week teacher training course for the participating instructors in the use of the instructional materials.

The control curriculum also was limited to a two-week (60 clock hours) block of instruction. Each school was permitted to select any subject it wished, to serve as the control subject for that school. This was to be presented by the same instructor who presented the experimental subject, but using his customary method and materials. Usually, the control subject was selected on the basis of the teacher's familiarity with the subject and the school's existing instructional program. A total of seven different control subjects was independently selected by the 12 schools, without any school's having knowledge of another school's selection prior to the start of the experiment.

Six teachers were assigned to each of two treatment groups. The justification for the assignment was based solely on the availability of the participating teachers at the time the classes were to be convened. The only condition stipulated by the Research Staff was that each treatment group include three public and three private schools from the randomly selected school population.

The preparation of the curriculum for the experimental subject, Aircraft Hydraulics, reflected the results of the National Survey previously completed during Phase I of the National Study of the Aviation Mechanics Occupation. The level of instruction for each task was specified on the basis of the Survey findings and a review by the National Advisory Committee. This established the depth to which the instruction would be developed in the Aircraft Hydraulics experimental curriculum. In addition to depth of instruction, which incorporated the levels of teaching and testing, the instructional materials included objectives written in behavioral terms that would identify the desired student performance goals, and a system of feedback between teacher and student that would establish a frequent input/output learning response.

In order to orient the teacher to the new curriculum design, it was necessary to conduct a one-week teacher training program at UCLA for the participating teachers. The two treatment groups were scheduled in the experimental sequence as shown in Table 1.

TABLE 1

BI-VARIATE INVERSION

TREATMENT GROUP A	TREATMENT GROUP B
Teacher Training	Teach Control Subject
↓	↓
Tch. Experimental Subject	Test Control Subject
↓	↓
Test Experimental Subject	Teacher Training
↓	↓
Tch. Control Subject	Tch. Experimental Subject
↓	↓
Test Control Subject	Test Experimental Subject
↓	↓
90-Day Retest Experimental/Control	90-Day Retest Experimental/Control

The experiment required coordinated scheduling of teacher training and class instruction for the two treatment groups. Treatment Group A initially attended the teacher training workshop at UCLA and received training in the use of the experimental curriculum and the methods and techniques of presentation. At the close of the first workshop, the six participating instructors returned to their schools and taught the experimental subject, Aircraft Hydraulics, for two weeks, followed immediately by two weeks of instruction in the control subject selected by the school.* Teachers assigned to Treatment Group B taught the self-selected subject in their usual manner for two weeks; then they attended the second one-week teacher training workshop at UCLA, where they received the same instruction in the use of the experimental curriculum. They then returned to their schools to teach the experimental Aircraft Hydraulics curriculum to the same students, for a period of two weeks.

---

*As a result of scheduling differences, two public schools initially participating in the program had to be omitted from the experiment. Both these schools had been included in Treatment Group A.

In all cases, the instructors presented the instruction to the same groups of students. Special examinations with validated questions were administered for each control subject and for the experimental subject. These examinations were given at the conclusion of the 60 hours of instruction for each treatment group, and the same test (in a different question sequence) was given 90 days later.

One week prior to the teaching of the control subject, the appropriate course objectives on which testing would be based were mailed to the participating teachers. Objectives for the experimental subject were clearly defined during the one-week teacher training workshop at UCLA. In every instance, classes were tested immediately following each 60-hour course of instruction and again after the 90-day period.

In order to determine the performance of the participating students on the Federal Avaiation Administration certification examinations for airframe and powerplant mechanics, a six-month follow-up feature was designed into the study. The purpose of the follow-up was two-fold: (1) to make a comparison between the control subject scores and the experimental subject scores of the student participants on the FAA certification examinations, and (2) to compare the control subject scores and the experimental subject scores of the experimental group with the national averages on the FAA certification examinations.

THE STUDENTS

Practically all of the 144 aviation mechanic students who participated in the controlled teaching experiment were high school graduates. Several of the participating students at one of the schools, however, were still attending high school and were enrolled concurrently in the aviation mechanic training program. A few students at two other schools that participated in the experiment were not high school graduates. Figure 1 summarizes the characteristics of participating students.

Number participating - 144

Age range - 17-45

Mean age - 22.7

Median age - 21.5

Mode - 19.0

College experience - 22 (6 graduated 4-year courses)

High School graduates - 135

Fig. 1
Student Characteristics

The students taking part in the experiment were in various phases within their schools' aviation curricula when the experiment and initial testing were performed. Following is a summary of student status in relation to completion of the aviation program for each of the participating schools; none of the students had received instruction in the experimental or control subjects prior to the experiment.

East Coast Aero Technical. The class was in Phase 4 of the 10-phase program.

Embry-Riddle Aeronautical Institute. The class was in the second trimester of the school program.

Emily Griffith Opportunity School. Because of the enrollment procedures used, the class consisted of students who were in various phases of course completion. That is, a student could enroll at any time a place was available for him, and when the training program had revolved full circle for him, he would graduate.

LeTourneau College. The class was beginning the fifth semester of the 6-semester aviation program.

Los Angeles Trade Technical College. The class consisted of students in various phases of their aviation mechanic training program.

Moody Bible Institute. The class was in the second month of the 11-month training program.

Northrop Institute of Technology. The class was in the ninth month of the 12-month program.

Oklahoma State University. The class was in the first year of the 2-year aviation mechanic program.

Pittsburgh Institute of Aeronautics. The class was in Phase 8 of the 12-phase program.

Seattle Community College. The class was in the second trimester of the school program.

THE SCHOOLS

The randomization principle was utilized in the study design in order to reduce any uncontrolled error variations. The participating schools were randomly selected from a list of 73 approved schools provided by the Federal Aviation Administration, Maintenance Division, Airmen and Schools Group, Washington, D. C. The list included all of the certificated Aviation Mechanic Schools in existence in the United States at the time of the experiment. A total of 12 sub-populations was selected from the total national aviation mechanic school population. This randomization included six public schools and six private schools.

Initial contact was made with the directors of the schools in the course of the selection process; these men were briefed on the aims of this phase of the study. Since the same teachers and the same students were to be used for both experimental and control treatments, the within-group error was minimized and between-group randomization was effected by using existing classes and teachers. It was stipulated, however, that teachers participating must have had at least three years of teaching experience in an aviation mechanics program.

No direct control was exercised over the selection of the teacher. It was pointed out, however, that the instructional environment normally existing in the school should be maintained, in order to nullify as much as possible the connotation of experimentation. Therefore, the teachers, students, and equipment involved in the study followed as closely as possible the normal school patterns, in order to hold scheduling changes to a minimum. Normal student progress was to be maintained and the very important criterion was stipulated that students taking part should not have received previous instruction in the subjects to be taught in the experiment.

The final randomized groups involved 12 different schools whose schedules were compatible with the scheduling of the experiment. Before the project was completed, however, it became necessary to omit two of the schools because it was found that they could not conform to all conditions established for the conduct of the program. The experimental project was completed by 10 schools.

All of the schools participating in the teaching experiment had Federal Aviation Administration certificated Airframe and Powerplant programs and, as such, met the minimum approved curriculum, hours of classroom and laboratory instruction, and other requirements for certification as delineated in Federal Aviation Regulations, Part 147, Mechanic Schools.

This included a minimum of 960 hours of instruction in Airframes or 960 hours of instruction in Powerplants, or a combined Airframes and Powerplants program of 1,650 hours, with a minimum of 60 percent of the total curriculum time being spent in shop and laboratory instruction.

The experiment was initiated with a group of participating schools that represented a geographical cross-section of the continental United States. Six of the schools were located east of the Mississippi River, and six were west of it. Two of the 12 schools were located in California; there was one school in each of the following states: Colorado, Florida, Illinois, Indiana, Massachusetts, New York, Pennsylvania, Oklahoma, Texas, and Washington.

INSTRUCTIONAL MATERIALS

Aircraft Hydraulics was selected as the experimental subject because all the students in the participating schools that were a part of the experiment had received no prior instruction in the subject when the experiment began. In addition, Hydraulics proved to be a good subject as it is one of the more difficult learning areas for students becoming aviation mechanics.

The curriculum contained three major instructional concepts: (1) student performance goals, (2) levels of instruction, and (3) immediate and continuous feedback from students to teacher. These major concepts also were incorporated in the instructional materials that were developed as integral parts of the experimental curriculum, in the form of coordinated texts for instructor and students.

Instructor's Guide

One of the coordinated texts, The Instructor's Guide to Aircraft

Hydraulics, contained all of the key points of information that the teacher was to present to his students. It was organized as a series of instructional units. It contained in detail the three major concepts cited above. Instructional unit objectives were included in the Guide to delineate the over-all objectives of the instructional unit. Student performance goals were used to indicate the objectives for the various instructional unit segments comprising each instructional unit. The student performance goals helped assure that each segment of learning occurred within the total instructional unit. See Appendix A for sample pages from the Instructor's Guide.

Levels of instruction designated in the Guide were designed so that the appropriate depth of training could be reached without over- or under-training. The specified levels of instruction provided the means for varying the emphasis on curriculum essentials and making the most prudent use of time in the instructional program.

Alongside the key points of information in the Guide which comprised the instructor's presentation was a parallel grouping of questions, problems and activities for continuous feedback from student to instructor. The feedback portion of the Guide was a pre-planned comprehensive listing of questions, problems, and activities that were consistent with what was being taught. It was utilized at the time that instruction was being given, to assure the teacher that there was satisfactory transfer of information to the students. The feedback items were designed to elicit either the student's re-statement of information or the performance of a task he had just learned. Further instruction did not commence until the instructor was satisfied with the results of the feedback.

The Instructor's Guide contained blank areas into which the instructor could insert (1) a listing of materials he planned to use in teaching the various instructional units, (2) notes concerning the motivation he desired to employ during the presentations, and (3) additional feedback questions, problems, or activities, along with other appropriate notations or reminders.

The Instructor's Guide was designed for use in conjunction with a Student Workbook in Aircraft Hydraulics. The Guide and Workbook were developed as companion books, to be used concurrently by teacher and the student. Notes at all vital teaching points in the Guide were keyed to matching points in the Workbook. This helped the instructor work closely with each student.

Student's Workbook

A Student Workbook in Aircraft Hydraulics closely followed the Instructor's Guide in format and informational content. The Workbook contained drawings related to the subject of Aircraft Hydraulics to assist the student during the learning process, along with hydraulics facts and statements that served to reinforce the teacher's lessons.

Each student participating in the experiment received a Workbook for use in conjunction with the instructor's lessons in Aircraft Hydraulics and for home study. During the course of instruction, the students could enter notes in spaces appropriately placed in the Workbook, which also contained step-by-step diagrams of basic hydraulics theory, a basic hydraulic system, and components and cross-sections of components used in a hydraulic system. In two sections of the Workbook there were partially completed diagrams showing the basic aircraft hydraulic system and operational hydraulic systems and subsystems, so that the students had the opportunity to complete the diagrams as the instructor lectured. The

Workbook also contained details of hydraulic components and systems, drawn and described in the form of hydraulic hardware, such as tubing, sealing rings, fittings, etc. Space was also provided for student drawings in various sections of the Workbook.

The Student Workbook was divided into five sections, corresponding with the five instructional units in the Instructor's Guide. The five instructional units were:

1. Basic Hydraulic Principles and Basic Aircraft Hydraulic Systems
2. Basic Hydraulic Components
3. Hydraulic Lines and Fittings
4. Hydraulic Fluids and Seals
5. Operational Hydraulic Systems, Subsystems, and Components

The Workbook contained comprehensive quizzes at the end of each section. The quizzes were assigned as homework and provided a means for review. Teachers could use completed Student Workbooks as one criterion in assigning grades for the course. See Appendix B for sample pages of the Student Workbook.

Audio-Visual Aids

A set of 27 color slides for use with a 35-MM projector was developed. The slides were accompanied by an audio tape.

The slides and tape were designed as an introduction to the course in Aircraft Hydraulics.

In addition, a set of transparencies with overlays was developed for use with an overhead projector. These were designed for use by the instructor at appropriate points in his presentation of the basic components and system of the aircraft hydraulics system.

It had been ascertained in advance that the audio-visual equipment required for use of these instructional materials was available in all participating schools. One complete set of the teaching aids described above was given to each participating instructor for use in presenting the experimental Aircraft Hydraulics curriculum to his students.

TEACHER TRAINING WORKSHOPS

Two teacher training workshops were held at UCLA, one in September, and the other during October, 1966. Each was attended by six aviation mechanic instructors, three from private schools and three from public schools. Identical programs were designed for the two workshops, which were conducted by the UCLA Research Staff.

The workshops opened with a presentation by the Research Staff concerning teaching principles and methods as synthesized in the section, "Definitions of Terms," of this report. The concepts were presented in relation to typical classroom situations. There was continued emphasis on the importance of student performance goals. Detailed discussion also was devoted to levels of instruction. The presence of four UCLA staff members who were former aviation mechanics and aviation mechanic teachers made it possible to clarify for the participating instructors any matters which they might have found difficult to translate in terms of actual classroom or shop practice.

Having laid the groundwork for the instructional techniques, the workshop program moved on to examination and discussion of the experimental Aircraft Hydraulics curriculum, presented through the media of the coordinated Instructor's Guide and Student Workbook. The Guide and Workbook were subjected to intensive examination and study on the part of all of the instructors. Along with the discussion of the curriculum, consistent emphasis was placed on identifying the teaching and testing levels in the Aircraft Hydraulics curriculum. The participating teachers then

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were shown audio-visual aids prepared by the Research Staff for use in teaching Aircraft Hydraulics.

Approximately one-third of the time allocated to the workshop was devoted to teacher practice in the use of the new materials and instructional methods. The 18 segments of instruction in the proposed new Aircraft Hydraulics curriculum were divided among the six instructor-participants. Each was assigned three segments of instruction or portions of segments to teach in half-hour lessons, using the Instructor's Guide. Teaching incorporated all that had been presented previously: use of student performance goals, levels of instruction, and feedback. The presentation of the subject matter was in line with the methods suggested in the Instructor's Guide. As each presentation was made, the other teachers and the Research Staff served as the "class" for the practice teaching. After each presentation, the teachers and the Research Staff conducted a critique of the practice teaching session.

Time was allowed at the end of the workshop for intensive discussion of over-all objectives, methods, course content and other matters of interest and concern to the teacher participants. At the close of the workshop, each instructor was given a set of the audio-visual aids described above for use in his school, along with a copy of the Instructor's Guide and a supply of the Student Workbook large enough to provide a copy for each of the students he would teach in the Aircraft Hydraulics class scheduled in connection with the educational experiment.

The second technical workshop followed the same sequence as the first. This workshop also was attended by six instructors, three from private and three from public schools.

EVALUATIVE INSTRUMENTS AND DATA COLLECTION

Data for the evaluation portion of the teaching experiment were derived from tests administered twice to the participating students--first, immediately after the close of instruction in both Aircraft Hydraulics and the teacher-selected control subjects, and again, three months later. Special examinations were prepared and administered with the cooperation of the Federal Aviation Administration Aeronautical Center in Oklahoma City, Oklahoma.

The selection of the test questions was based on the difficulty index, validity index, and testing level (i.e., knowledge, comprehension, etc.) for each question. The difficulty index and the validity index numbers were determined by the high-low 27 percent method, wherein the performance of the top 27 percent of a study group is contrasted with the performance of the lowest 27 percent. The index numbers were based on analysis of randomly selected answer sheets of tests administered to "A&P" certification candidates at FAA-approved aviation mechanic schools.* The difficulty index of the experimental subject test and the control subject tests were at similar acceptable difficulty levels.

The examinations for Aircraft Hydraulics and for the school-selected control subjects--Aircraft Electricity, Assembly and Rigging, Pressurization and Air Conditioning, Propellers, Sheet Metal, Theory of Flight, and Woodworking--were specially printed, each subject in a separate booklet. Multiple-choice questions made up each test. A separate IBM answer sheet was used, on which the student marked off the replies he considered correct. For the three-month retention test, the original examination questions were used again, but were shifted in position to make it less obvious that the re-examination was identical in content with the initial test. Answers again were recorded on IBM answer sheets.

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*"A&P" Designates Airframe (A) and Powerplant (P).

The FAA cooperated in data collecting by assigning representatives in its local General Aviation District Offices to administer the initial tests in schools in their respective areas of jurisdiction. These representatives were provided with instructions concerning the standards and testing procedures to be used during the experiment, as formulated by the UCLA Research Staff. The answer sheets were forwarded to the research office for scoring and tabulation.

Since student retention of instructional material was an important part of the experiment, re-testing of participating students was scheduled as the means of evaluating this factor. The re-testing for retention was conducted three months after the initial testing. Scores were included in the study data for only those students who took the initial tests in experimental and control subjects and the re-tests in these subjects. Those students who failed to take all four tests were omitted from the study population.

The Federal Aviation Administration certification examinations for Airframe and Powerplant mechanics are, in most cases, taken by the students soon after completion of the aviation mechanic training program. They usually are taken in the FAA district in which the school is located. In view of this practice, the assistance of the FAA Aeronautical Center in Oklahoma City, Oklahoma, was requested for the purpose of conducting a six-month follow-up study of the students who participated in the experiment. The FAA cooperated in the research by providing scores on the sections of the A&P examinations applicable to the study, in the form of national averages and individual scores of the participating students.

RESULTS

Since all of the sub-populations were designated at random from the same population, which was the certificated aviation mechanic schools throughout the United States, the "simple random replication" design described by Lindquist[1] has been applied in analyzing the data. The same treatment was administered concomitantly to Treatment Group A and Treatment Group B, but in inverted experimental sequence (see Table 1). This

TABLE 2

DISTRIBUTION OF MEANS AMONG SUB-TREATMENTS
(N = 144)

Sub-Populations	Mean Scores by Sub-Treatments*			
	X_1	C_1	X_2	C_2
TREATMENT GROUP A				
Sub-Population # 1 (N=10)	21.80	18.80	19.90	17.20
Sub-Population # 2 (N=10)	24.10	17.20	20.70	16.40
Sub-Population # 3 (N= 8)	22.25	17.87	20.50	17.25
Sub-Population # 4 (N=28)	24.36	21.93	22.64	19.32
TREATMENT GROUP B				
Sub-Population # 5 (N=14)	25.36	19.29	24.57	20.78
Sub-Population # 6 (N=14)	23.71	14.43	24.36	17.14
Sub-Population # 7 (N=10)	20.10	13.90	20.40	16.40
Sub-Population # 8 (N=22)	21.50	16.32	19.00	18.95
Sub-Population # 9 (N=10)	19.50	15.50	21.80	16.80
Sub-Population #10 (N=18)	23.05	15.44	21.94	15.83
TOTALS, GROUPS A & B (N=144)	22.48	17.00	21.72	17.91

* X_1 = Experimental Subject, 1st test; X_2 = Experimental Subject, re-test; C_1 = Control Subject, 1st test; C_2 = Control Subject, re-test.

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[1] Everett F. Lindquist. Design and Analysis of Experiments in Psychology and Education. (Boston: Houghton-Mifflin Company, 1953), pp. 12, 13, 47, 101.

was intended to reduce any order effect that might be present in the experiment. The different sub-treatments (i.e., X_1, X_2, C_1, C_2) within each sub-population, therefore, are the different sets of examinations administered to the same students having the same teacher. The distribution of the mean among sub-treatments is displayed in Table 2.

The "t" test ($t = \frac{\overline{D}}{\text{est'd.}\,\sigma_{\overline{D}}}$) was applied to the simple random replication. Although a five percent level of significance was adopted for this study, when sub-treatment X_1 was compared with sub-treatment C_1 a "t" score of 8.28 was found, which is significant to the .1% level. In comparing sub-treatment X_2 with C_2, it was found that a "t" score of 6.43 existed, which also is significant to the .1% level of confidence. The null hypotheses can therefore be rejected. The experimental treatment applied in sub-treatments X_1 and X_2, as opposed to the control treatment applied in C_1 and C_2, would indicate that when teachers are given specially prepared materials and are trained in the use of these materials, learning in greater depth will take place. In order to further substantiate this assumption, however, it is necessary to proceed with an in-depth analysis of the collected data.

Treatment Group A and Treatment Group B received the same instructional treatment, but in different sequence, as was explained previously. In order to evaluate the effect of the bi-variate inversion design, each treatment group was analyzed and findings recorded in Table 3 according to sub-treatments X_{1-C_1} X_{2-C_2}, using the Fisher "t" as the test of significance.

The computations indicate that the significance of the "t" test in the random replications design was not substantially influenced by any within-group variations due to the difference in sequential presentation

TABLE 3

SUB-TREATMENT MEANS AND LEVELS OF SIGNIFICANCE, BY GROUPS

(N = 144)

TREATMENT GROUPS	Sub-treatment Means				"t" Signif. Level	
	X_1	C_1	X_2	C_2	X_1-C_1	X_2-C_2
Treatment Group A (N=56)	23.55	19.94	21.50	18.03	.1%	.1%
Treatment Group B (N=88)	22.39	15.13	21.87	17.78	.1%	.1%

of the experimental and control materials. It is to be noted that a slight loss in retention occurred in Treatment Group A, as indicated by the reduction in mean scores between the testing X_1 and X_2, on the experimental subject, and the testing C_1 and C_2, on the control subject. This was not the case in Treatment Group B, where the control subject scores increased on the re-test. Upon investigation, it was learned that five of the six schools had provided additional instruction in the control subject between the first testing and the re-testing. The amounts of additional instruction varied up to a maximum of 60 additional hours in one school. It must be especially noted at this point, however, that although extra instruction in the control subjects was provided, the "t" score of significance remained at the .1% level when the re-tests X_2 (experimental subject) and C_2 (control subject) were compared.

Since the total significance level for the ten sub-populations had previously been determined at the .1% level of significance for X_1C_1, and the .1% level for X_2C_2, an additional test for significance seemed appropriate. Each sub-population, therefore, was tested for individual significance for X_1C_1 and for X_2C_2. The results of these computations are recorded in Table 4.

TABLE 4

SIGNIFICANCE LEVELS OF INITIAL TEST AND RE-TEST SCORES BY SUB-POPULATIONS

(N = 144)

Treatment Groups	"t" Significance Level	
	X_1C_1	X_2C_2
Treatment Group A		
Sub-Population # 1	15.0%	(n.s.)
Sub-Population # 2	0.1%	1.5%
Sub-Population # 3	4.0%	10.0% * **
Sub-Population # 4	1.0%	1.0%
Treatment Group B		
Sub-Population # 5	0.1%	0.1% *
Sub-Population # 6	0.1%	0.1% *
Sub-Population # 7	1.0%	7.5% *
Sub-Population # 8	0.1%	(n.s.) * **
Sub-Population # 9	1.0%	1.0% *
Sub-Population #10	0.1%	0.1%

*School provided additional instruction in control subject between test and re-test, up to a maximum of 120 hours. **School provided additional instruction in experimental subject up to a maximum of 80 hours, between test and re-test.

It is observed that in nine of the ten sub-populations, very high significance levels were indicated for results of the initial testing, all of them testing below the five percent level. In only one case was the five percent level exceeded. When the same tests were administered approximately 90 days later, scores for six of the original ten schools continued to be significant at the less than five percent level. The three schools that exceeded the five percent level of significance proved to have at least doubled (and in one case tripled) the specified amount of instruction in any one subject.

Because six of the ten schools provided additional instruction in the control subjects prior to the re-examinations, and three of the remaining four schools provided instruction in the control subjects as the most recent subjects prior to the re-examination, the possibility of evaluating the retention effect in the experiment was negated. For example, on the basis of initial testing, the students learned more in the experimental subject than in the control subjects; and after re-testing the scores continued to be higher in the experimental subject than either the original or the re-testing scores in the control subjects.

It would appear, then, that the student would, upon initial employment, enter the occupation with a broader base of knowledge, as measured by the examinations, in Aircraft Hydraulics than in any of the control subjects, such as Sheet Metal, etc. In order to test this assumption, a six-month follow-up program was conducted.

SIX-MONTH FOLLOW-UP

Six months after administration of the re-tests in Aircraft Hydraulics and the control subjects, a follow-up was made of the students who participated in the experiment. The purpose of the follow-up program was to determine each student's success with the Federal Aviation Administration's certification examinations in the subject areas included in the study.

If the student took the FAA Airframe and Powerplant examinations in the same district as the school in which he received training, it was possible to obtain the desired information. With the assistance of the FAA, scores on certification examinations were obtained for 68 percent of the students. Another 19 percent of the students had completed training, but records of their FAA examination scores were not available. The remaining 13 percent of the students failed to complete the school program for personal, scholastic, and other reasons. Grades on the A&P examinations were obtained for 98 of the 144 students who participated in the experiment, and are included in the follow-up study.

The Airframe section of the FAA certification examination consisted of five parts: (1) Rigging and Assembly; (2) Wood, Fabric Covering, and Dope; (3) Sheetmetal and Welding; (4) Hydraulic Systems and Components, and (5) Electrical Systems and Components.

There were six parts in the FAA Powerplant examination: (1) Carburetors and Carburetion; (2) Magnetos and Ignition Systems; (3) Theory and Maintenance of Powerplants; (4) Lubrication and Oiling Systems; (5) Propellers; and (6) Electrical Systems and Components.

It was possible to include the scores for Hydraulics and for five of the seven control subjects in the statistical analysis of the FAA examination data; material concerning Theory of Flight and Air Conditioning and Pressurization was incorporated into various portions of the tests, so that no specific groupings of scores could be identified for the purposes of this analysis.

Scores were available, therefore, for Assembly and Rigging, Woodworking, Sheetmetal, Electricity, and Propellers. The experimental subject, Aircraft Hydraulics, provided a very reliable measure because of the homogeneity of its organization on the FAA examination.

The national means for each section of the tests and the means for the total experimental population are compared in Table 5.

In all cases, the mean scores for the experimental population exceeded the national means on the FAA examinations. It is important to note that the difference for Aircraft Hydraulics is higher than for any other subject. Propellers and Assembly and Rigging are the only two subjects other than Aircraft Hydraulics for which students who participated in the experiment have significantly exceeded the national means. However, the mean differences of 2.9 for Propellers and 3.1 for Assembly and Rigging are below the positive mean difference in Aircraft Hydraulics.

TABLE 5

COMPARISON BETWEEN NATIONAL AND EXPERIMENTAL MEANS ON FAA CERTIFICATION EXAMINATIONS

Subject	Mean Scores National	Mean Scores Experimental Group	Difference
Assembly and Rigging	74.1	78.4	+ 4.3
Wood	75.8	76.5	+ 0.7
Sheetmetal	75.6	76.2	+ 0.6
Electricity	71.1	73.5	+ 2.4
Propellers	72.9	77.4	+ 4.5
HYDRAULICS	72.9	80.3	+ 7.4

To determine the significance of the differences in the mean score for Aircraft Hydraulics and for each of the control subjects, the Fisher "t" Test was applied to the data. The total of 98 students was included in the analysis; the results are shown in Table 6.

TABLE 6

COMPARISON BETWEEN CONTROL AND EXPERIMENTAL MEANS ON SIX MONTH FOLLOW-UP

(N = 98)

	Control Subject (Mean)	Hydraulics (Mean)	Difference in Means	"t" score
Assembly & Rigging	78.4	80.3	+ 1.9	10.0%
Wood	75.8	80.3	+ 4.5	1.0%
Sheetmetal	76.2	80.3	+ 4.1	2.0%
Electricity	73.5	80.3	+ 6.8	0.1%
Propellers	77.4	80.3	+ 2.7	8.0%

It is to be noted that the mean score for Aircraft Hydraulics was higher than the means for each of the control subjects. However, upon examination of Table 5, it is evident that all but one of the control subjects were of equal or lower levels of difficulty than Aircraft Hydraulics, when judged by the national means. Results for Wood, Sheetmetal and Electricity were significant to less than the five percent level of confidence which was established when the study was initiated. Assembly and Rigging and Propellers were significant to the 8 percent and 10 percent levels respectively.

The follow-up analysis again appears to support the rejection of the null hypotheses and substantiate the experimental treatment as significantly contributing to both learning and retention. This has occurred even though Aircraft Hydraulics was one of the more difficult areas for students taking the FAA certification examinations.

The findings of the six-month follow-up study further substantiated the assumption that a broader base of knowledge exists for entry employment in Aircraft Hydraulics than appears to exist in the control subjects.

SUMMARY

This study was conducted in both public and private aviation mechanic schools throughout the United States. A total of 12 schools participated in the experiment and a random replications design was used with the inclusion of a bi-variate inversion method for controlling the treatment order. A total of 144 students was used in the initial test and re-test sequence, and the six-month follow-up study included 98 of the original students.

The experimental subject in the study was Aircraft Hydraulics, for which instructional materials were provided, along with teacher training in the use of the materials. The control subjects were selected by the teachers. Seven different control subjects were used by the schools in the experiment. Both the control subject and the experimental subject, however, were taught by the same teacher to the same students in each of the sub-populations.

The results of the experiment were analyzed through controlled testing following the completion of the 60 clock hour course in Aircraft Hydraulics and a 60 clock hour course in the control subject. The retention effect was studied following a 90 day re-test in the same subjects. This was further substantiated by a six-month follow-up study utilizing the scores of the FAA certification examinations.

The test of significance of the treatment indicates convincingly that in almost every case the sub-populations performed better in Aircraft Hydraulics than in any of the control subjects, despite an almost comparable difficulty index for the several examinations. It was not the intent of the experiment to measure in isolation each technique and concept used in the innovated curriculum materials. This is normally the approach in educational research. The learning process, however, is more complex, and each part is supportive or contributive to the whole concept. This study emphasized the basic teaching tools that can be made available to all teachers, irrespective of the sophistication of the technical equipment available or the economic level of the school. Elements tested in the experimental approach included:

1. Designing the curriculum to include levels of instruction.
2. Identifying desired outcomes through student performance goals.
3. Developing coordinated instructor's guide, student workbooks, and training aids.
4. Training teachers to use the coordinated instructional materials and to apply the concepts of student performance goals and feedback in their teaching.

5. Using feedback to constantly ascertain the amount of learning that is taking place.

6. Testing for student performance goal achievement.

It has not been the purpose of this research to evaluate the influence of any single one of the above elements as an entity in measuring the effectiveness of the instruction. Each, however, has contributed to an improved learning environment which can be controlled by the individual teacher if he has been given the proper knowledge for implementation. Evaluation of the experimental data suggests the following deductions; however, caution must be exercised in making definitive conclusions in light of the limited scope of this study.

1. When student performance goals are clearly defined and are known by both the teacher and the student, the quality and quantity of the learning will improve.

2. When the levels of instruction are known and adhered to, more efficient instructional planning and therefore more efficient classroom instruction will take place.

3. When feedback checks for learning are prepared in detail prior to each lesson and the teacher utilizes feedback during instruction, student learning progress increases.

4. When improved instructional planning and teaching methods are used, instructional time may decrease without a loss in learning.

5. When teachers are trained to use instructional materials and utilize concepts concerned with student performance goals and continuous feedback, students achieve greater depth of learning and retention.

Some indications suggest that the number of instructional hours devoted to the subject is not the only important criterion for increased learning. In this study, it was noted that regardless of the number of hours devoted to teaching the control subjects, students failed to achieve the same level of excellence on the examinations as in the experimental subject. In fact, performance in some areas declined with increased instruction, suggesting the possibility of retroactive inhibition. Study results suggest that the use of levels of instruction, student performance goals, and feedback in instructor preparation, curriculum organization, and instructional planning can influence to a greater extent than usually is anticipated the amount of time necessary to teach a particular subject. It must further be emphasized that without proper teacher preparation and acceptance of the experimental concepts, regardless of the amount of previous teaching experience, the success of the instruction and of learning achievement will be limited.

It would appear, therefore, that students will enter the aviation mechanic occupation with a broader base of knowledge from which the retention effect would operate in proportion to the influence of time and use, when the instructional methods tested in this experiment are implemented.

APPENDIX A

SAMPLE PAGES FROM INSTRUCTOR'S GUIDE TO AIRCRAFT HYDRAULICS

INSTRUCTIONAL ANALYSIS

UNIT V: Operational Hydraulic Systems, Sub-Systems, and Components

UNIT OBJECTIVES:	1) The student will be able to apply the principles of hydraulics to the operation of both open-center and closed (regulated pressure) hydraulic systems. 2) The student will be able to identify, inspect, operationally check, remove, replace, and repair components of master brake systems, landing gear, and flap systems. 3) The student will demonstrate his knowledge by diagramming and explaining the operation of power brake systems, nose gear steering, and boosted flight control systems.
MATERIALS:	"Student Workbook in Aircraft Hydraulics"
MOTIVATION:	

UNIT V

SEGMENT OBJECTIVE A:

1) The student will be able to explain the operation of an open-center system and compare the advantages and disadvantages to a closed (regulated pressure) system, either orally or in writing.

2) The student will be able to identify open-center type selector valves and filters, and he will check, remove and replace, inspect, and service these components in the system.

PRESENTATION

1. Identify and describe (5A 1.)
    a. Open-center selector
    b. Operation of open-center system
    c. Discuss advantages/disadvantages

FEEDBACK

1. The student will diagram an open-center system on controlled note sheet and describe operation of the system.
    a. What pressures exist in an open-center system when the pumps are operating and the selector valve is in a neutral position?
    b. What pressures exist in the pressure manifold of a closed system when the pumps are operating and the selector valve is in a neutral position?
    c. What pressures exist in an open-center system when the pumps are operating and the selector valve is in a selected position?

d. When the actuator of an open-center system reaches the end of its travel, what occurs?

e. What causes an open-center selector valve to move to a neutral position?

f. How is a selector valve in a closed hydraulic system moved to a neutral position?

g. Why is an accumulator unnecessary to the operation of an open-center system?

#2. Demonstrate procedure for inspecting and operationally checking an open-center system and a closed system. (5A 2.)

#2. Student will operationally check an open-center system and a closed system.

a. What is the pressure in the system before the pump(s) begins to operate?

b. What is the pressure in the system after the pump(s) is operating?

c. Why does the actuator in an open-center system move so slowly after the selector valve has been moved to an "up" or "down" position?

	d. Describe why the pump produces a varying level of sound during the movement of the actuator. e. What causes an open-center selector valve handle to return to its neutral position?
#3. Demonstrate procedure for adjusting an open-center selector valve. (5A 3.)	#3. Student will adjust the handle release pressure of a selector valve. a. To what information would you refer in order to determine correct "kick-out" pressure? b. If the time delay between the time that the actuator reached full travel and the handle returned to neutral was excessive, what would be the fault? c. What problem would exist if the handle release pressure was adjusted too low?

UNIT V

#4. Demonstrate procedure for removal and reinstallation of an open-center selector valve and servicing of filters. (5A 4.)

#4. Student will remove and reinstall an open-center selector valve in the system and service the filter:

a. What procedure is necessary (with regard to system pressure) before disconnecting lines to the selector?

b. Is a selector valve structurally mounted in the airplane, or is it supported by the hydraulic tubing?

c. What procedure is followed to avoid loss of fluid and entrance of dirt and contamination when removing the selector valve?

d. If air is trapped in the alternating lines from the selector to the actuator, how is this air eliminated from the system?

e. Why do some filters not incorporate a "by-pass" relief valve?

f. Why are paper type filter elements normally discarded and replaced with new elements rather than being cleaned?

g. To what information would you refer to determine the "service inspection" period for replacement of a porous paper hydraulic filter element?

h. What could cause an external fluid leak following replacement of a filter element?

UNIT V

SEGMENT OBJECTIVE B:

1) The student will diagram a master cylinder brake system and be able to explain the operation of the system.

2) He will identify master cylinders; inspect, service, remove, install, and replace "O" ring packings and/or seals; and operationally check the system.

3) He will identify shoe type, expander tube type, and disk type brakes and be able to explain their operation. He will inspect, service, adjust, and replace parts demonstrating "return to flight" standards of workmanship.

PRESENTATION

1. Master cylinder brake system (5B 1.)
   a. Describe operation
      - master cylinder
      - wheel cylinder
   b. Discuss advantages/disadvantages by comparison with mechanically actuated brakes

FEEDBACK

1. Student will diagram a master cylinder brake system on the controlled note sheet and describe in writing the operation of the system:
   a. What purpose does a master cylinder serve in a brake system?
   b. In order to provide differential braking action to the left and right brakes, how many master cylinders will be required?
   c. What advantages do individual brake cylinders have in steering the airplane while it is being taxied?

d. If only one hand-operated master cylinder is installed in the airplane, how can brake pressure be supplied to both wheels?

e. Describe how you would apply and release parking brakes.

f. Compare hydraulically actuated and mechanically actuated brakes and discuss the advantages and disadvantages of each.

g. Why do some master cylinder systems have external reservoirs and other master cylinders do not?

h. What is the purpose of the threaded adjustment at the piston rod of the master cylinder?

i. Explain your understanding of the term "compensating port."

j. What type of brake fluid should be added to a master cylinder which has pure rubber seals?

k. Some airplanes incorporate a parking brake. Explain what happens if the brakes are in "parking" position and a temperature increase takes place in the fluid of the brake system.

l. What happens if there is a fluid leak at the wheel brake cylinder?

m. What happens if there is an internal leak in a master cylinder?

n. How could a master cylinder with an internal leak be detected?

o. How can excessive brake clearance affect the operation of a master brake system?

2. Shoe type brake (5B 2.)
    a. Nomenclature
    b. Describe operation
    c. Compare hydraulic and mechanical actuation
    d. Servo-action
        - single
        - duo

1. Identify by correct nomenclature all of the following items:
    a. Torque plate or spider
    b. Brake actuating cylinder
    c. Brake shoes
    d. Brake linings
    e. Anchor pin
    f. Star adjusting wheel
    g. Return springs
    h. Eccentric cams
2. Explain how force is applied to the brake shoes.

3. Why are single-servo shoe type brakes unsatisfactory as parking brakes?

4. What purpose do the return springs serve?

5. Explain why a single-servo brake has only one piston in the brake wheel cylinder. Why does a duo-servo brake have two?

6. How do you distinguish between a primary and secondary shoe of a brake?

7. If the return springs are of different strength, which of the springs is attached to the primary brake shoe?

8. What purpose do the eccentric cams serve in a shoe type brake?

9. What is the purpose of the star wheel adjustment?

#3. Demonstrate the inspection and adjustment of a shoe type brake. (5B 3.)

#1. Student will inspect a shoe type brake, and adjust to a specified clearance:

a. What are some defects in the shoe type brake assembly that may cause brake drag?

b. How can a small amount of grease or oil be removed from the lining?

c. What damage will be done to the brake if pressure is applied while the wheel is removed?

d. How do you identify a brake lining that is glazed?

e. What action do you take if the lining has become saturated with grease and oil?

f. What material do you use to clean the rubber seals and dust covers of the brake cylinder?

g. What material do you use to clean the metal parts of the brake?

h. What tool is used to check the clearance between the brake drum and the lining of the shoes?

i. Why shouldn't the wheel be rotated with the feeler gage inserted?

j. How could you detect an "out-of-round" brake drum?

k. Why should a clearance recheck be made after the brake has been applied?

UNIT V

4. Expander tube type brake (5B 4.)
   a. List nomenclature.
   b. Describe operation .
   c. Explain why it cannot be mechanically actuated.

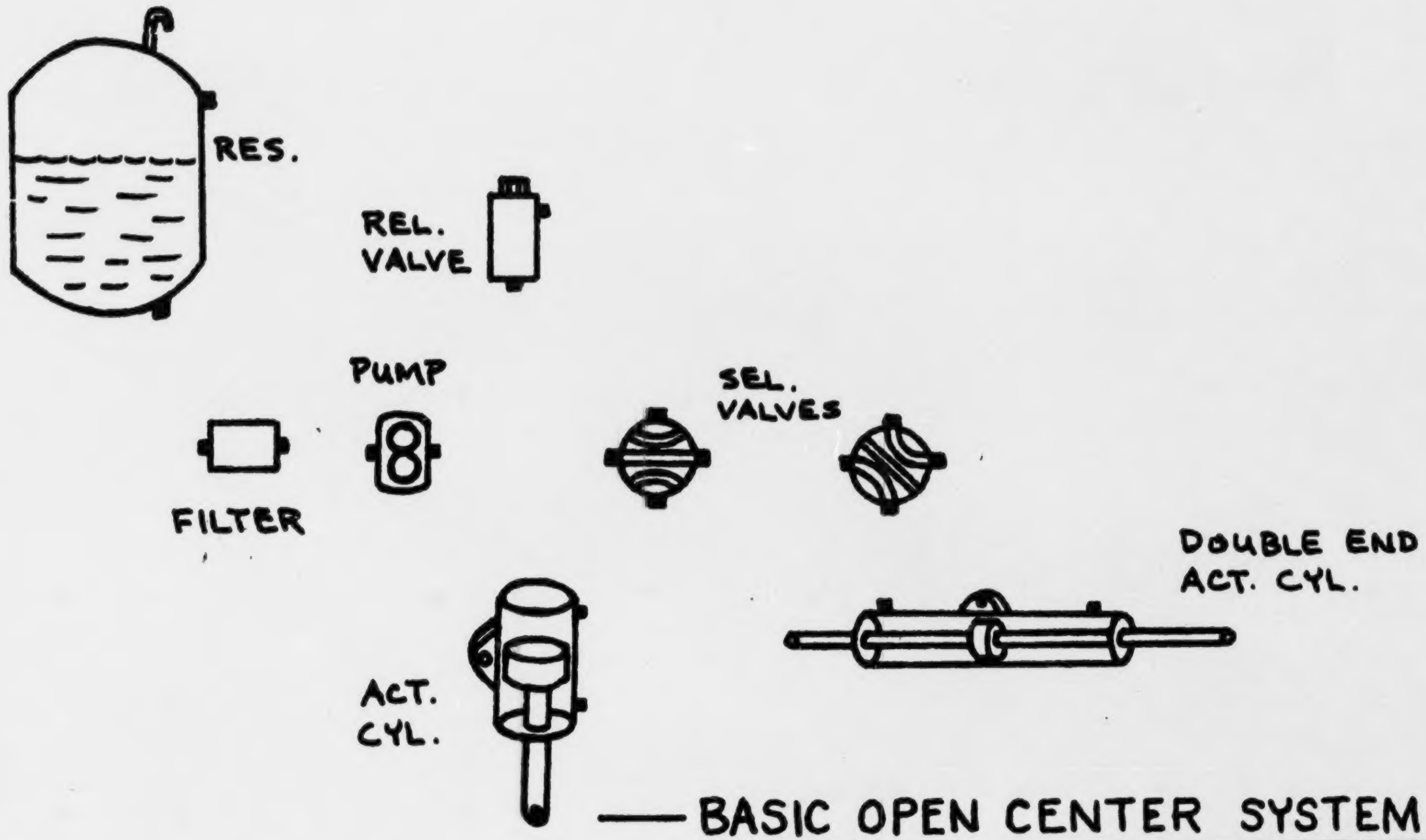
1. Identify by correct nomenclature all of the items illustrated on the controlled note sketch sheet:
   a. Expander tube
   b. Block segments
   c. Brake frame
2. Why can't this brake be mechanically actuated?
3. What happens if this type of brake has a stretched or swollen expander tube?
4. Why are all of the block segments replaced at the same time rather than replacing them one at a time?
5. How is the brake frame attached to the strut or axle of the airplane?
6. How are the block segments anchored to the brake frame?
7. What causes the block segments to return following application of hydraulic pressure inside the expander tube?
8. What feature of this brake prevents extrusion of the expander tube between the block segments?
9. Explain why there is no "servo" action to an expander tube type brake.

APPENDIX B

SAMPLE PAGES FROM STUDENT WORKBOOK IN AIRCRAFT HYDRAULICS

OPERATIONAL HYDRAULIC SYSTEMS

Section 5A


RES.
REL. VALVE
PUMP
SEL. VALVES
FILTER
DOUBLE END ACT. CYL.
ACT. CYL.

BASIC OPEN CENTER SYSTEM

5A 1. Identify and explain

a. Open center selector

b. Operation of open center system

c. Advantages and disadvantages

5A 2. Procedure for inspecting and operationally checking an open center system and a closed system.

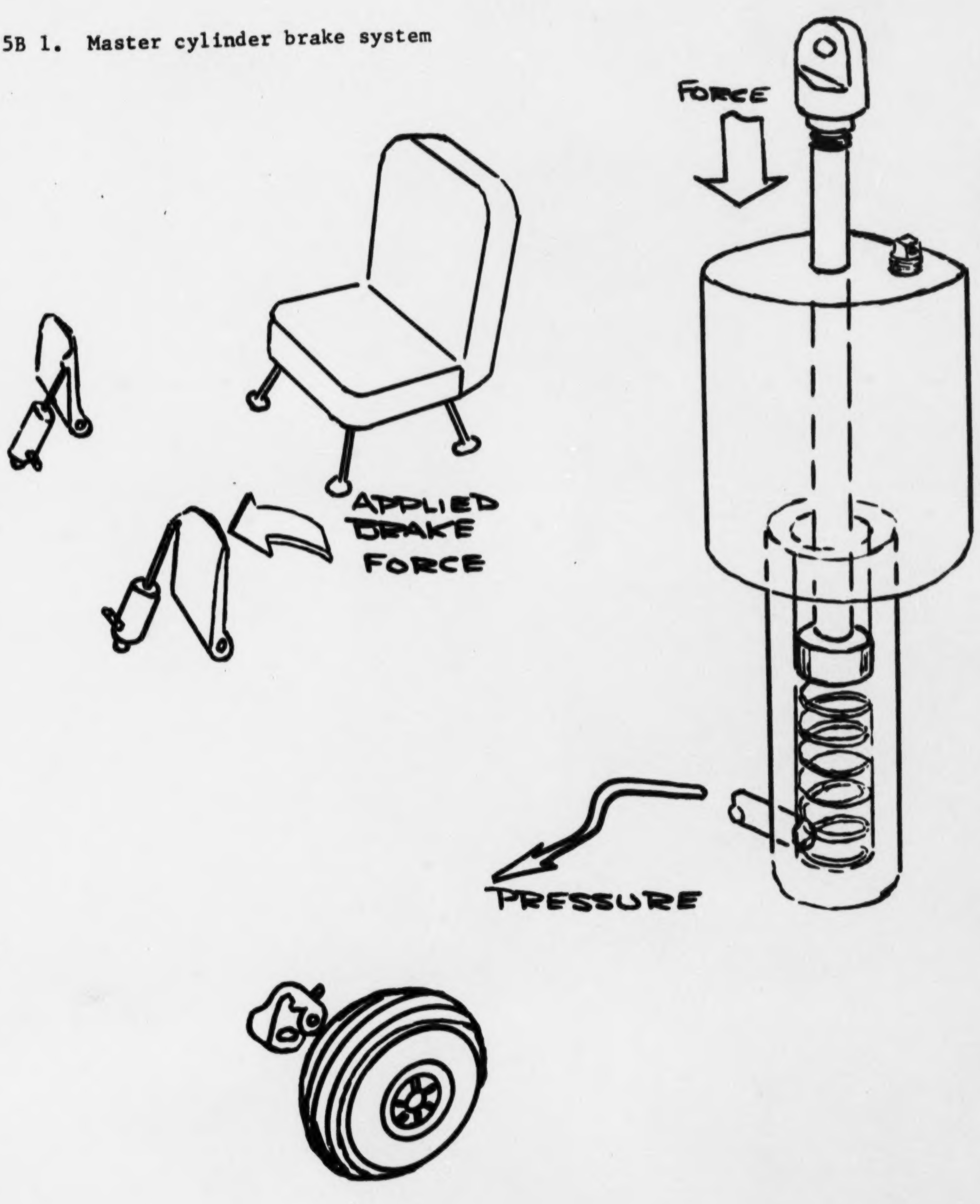
5A 3. Procedure for adjusting an open center selector valve.

5A 4. Procedure for removal and installation of an open center selector valve and servicing of filters.

HYDRAULIC SUB-SYSTEMS AND COMPONENTS

Section 5B

5B 1. Master cylinder brake system


FORCE
APPLIED BRAKE FORCE
PRESSURE

Section 5B (cont.)

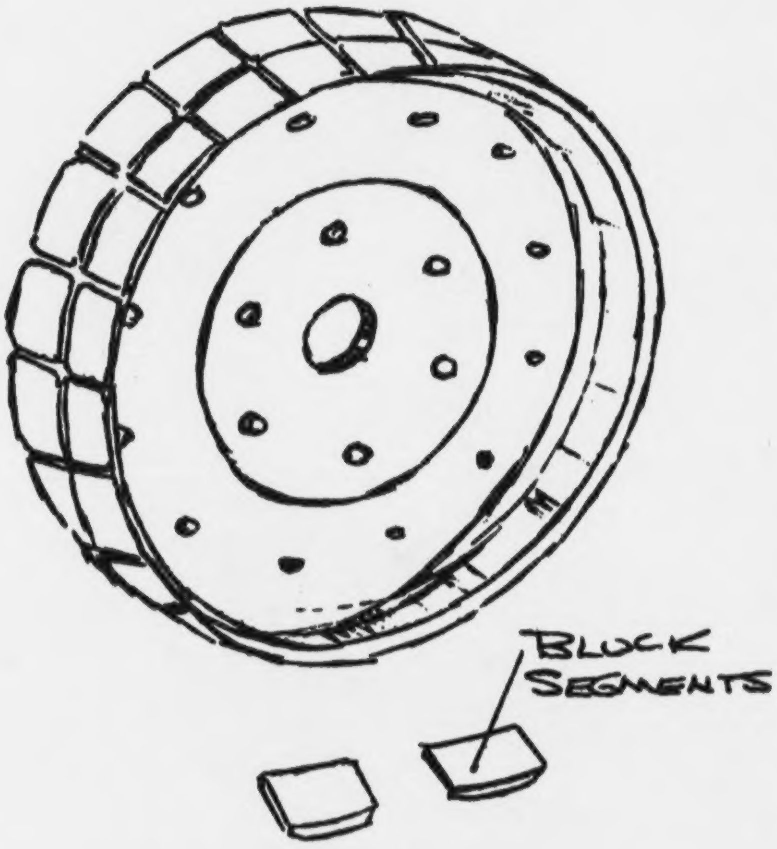
5B 1. Master cylinder brake system

- a. Operation
  - 1. Master cylinder
  - 2. Wheel cylinder
  - 3. Advantages and disadvantages

5B 2. Shoe type brake

- a. Nomenclature
- b. Operation
  - 1. Hydraulic actuation
  - 2. Mechanical actuation
- c. Servo action
  - 1. Single
  - 2. Double

5B 3. Inspection and adjustment of a shoe type brake



5B 4. Expander tube type brake

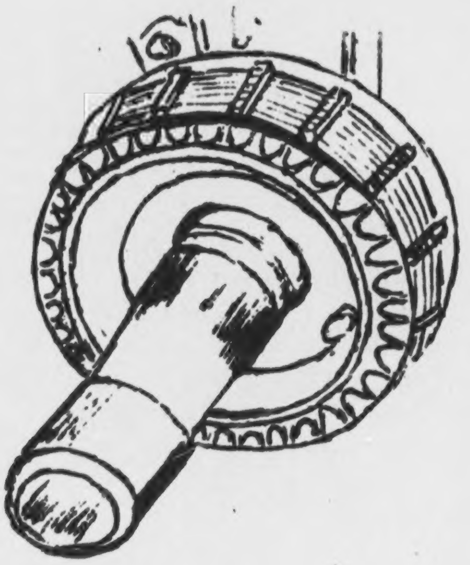
a. Nomenclature

b. Operation

5B 5. Inspection and adjustment of an expander tube brake

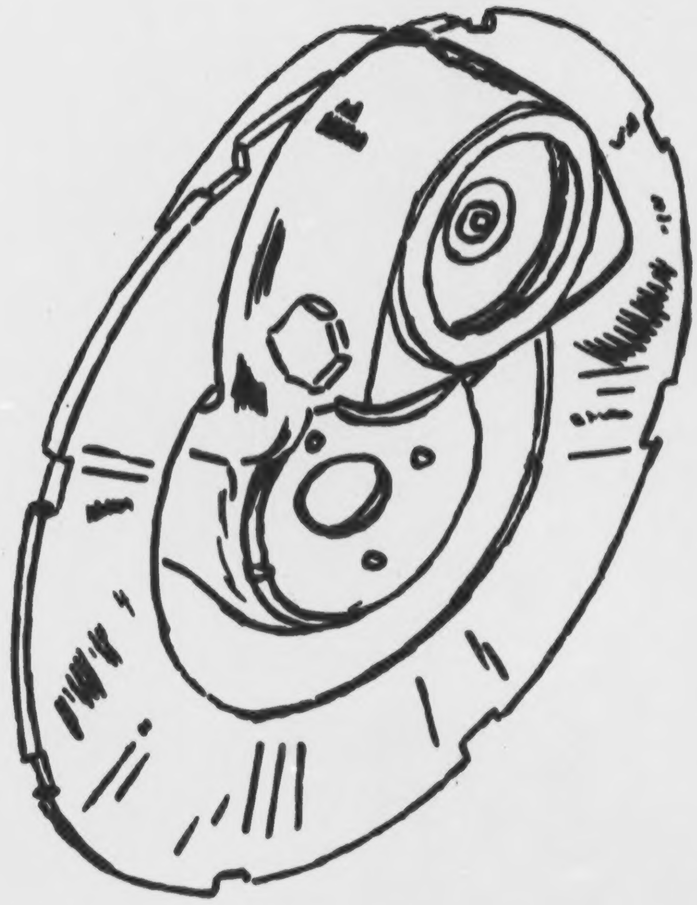
5B 6. Multiple disk brake

a. Nomenclature



b. Operation

5B 7. Inspection and adjustment of a multiple disk brake



5B 8. Single disk brake

a. Nomenclature

b. Operation

Section 5B (cont.)

5B 9. Inspection and adjustment of a single disk brake

5B 10. Operationally check, bleed, and service master brake systems

a. Gravity method

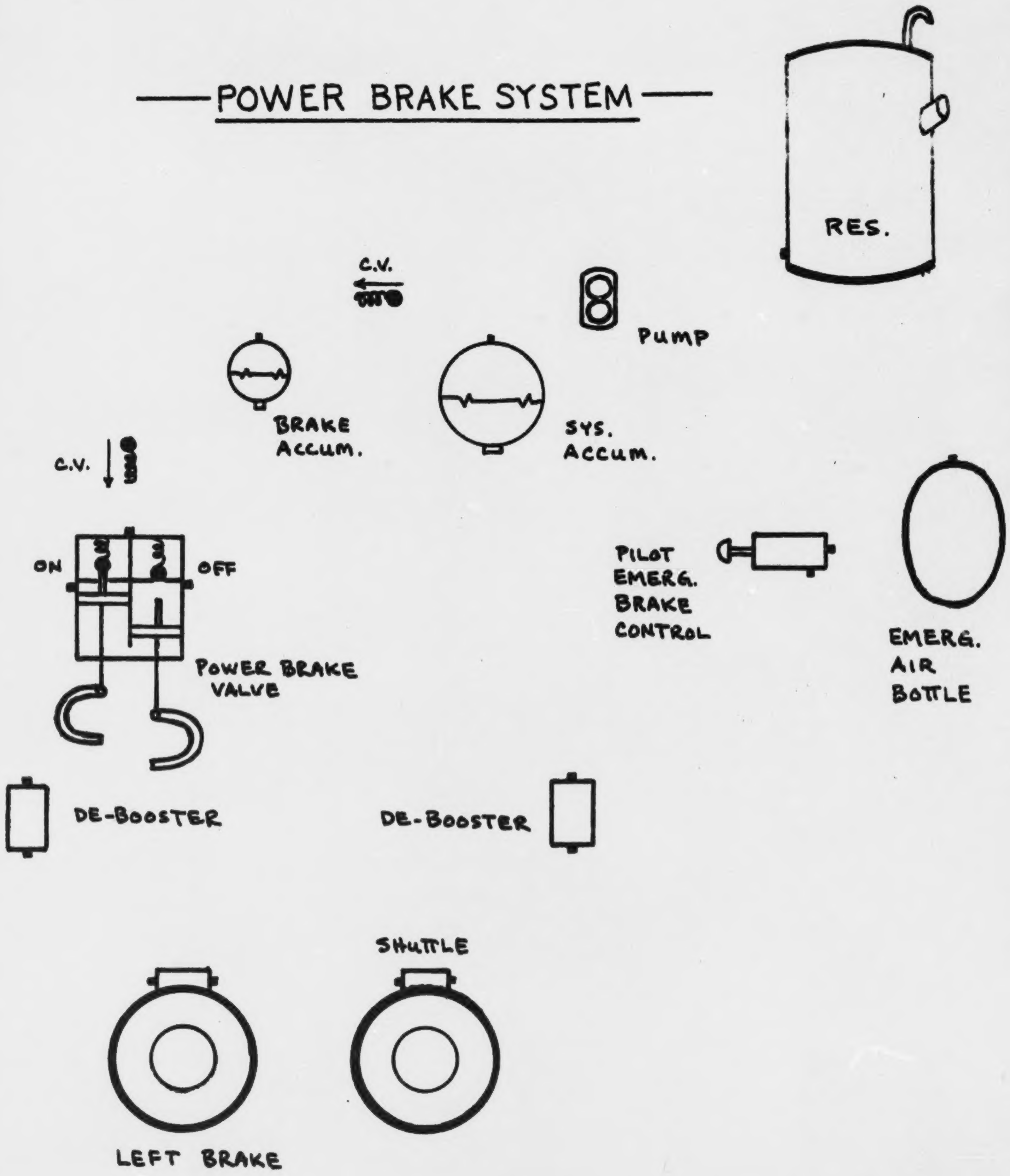
b. Pressure method

5B 11. Procedure for assembly/disassembly of a master brake cylinder and the replacement of seals

HYDRAULIC SUB-SYSTEMS AND COMPONENTS

Section 5C

POWER BRAKE SYSTEM


RES.
C.V.
PUMP
BRAKE ACCUM.
SYS. ACCUM.
C.V.
ON
OFF
POWER BRAKE VALVE
PILOT EMERG. BRAKE CONTROL
EMERG. AIR BOTTLE
DE-BOOSTER
DE-BOOSTER
SHUTTLE
LEFT BRAKE

APPENDIX C

SCHOOLS AND INSTRUCTORS PARTICIPATING IN EXPERIMENT

School	Instructor
Aviation High School	S. Frontario
East Coast Aero-Technical School	J. Little
Embry-Riddle Aeronautical Institute	I. Cherry
Emily Griffith Opportunity School	A. Lagger
LeTourneau College	J. C. Harder
Los Angeles Trade-Technical College	P. Glennan
Moody Bible Institute	R. Rich
Northrop Institute of Technology	R. Enslen
Oklahoma State University	H. Evans
Pittsburgh Institute of Technology	J. Shanahan
Purdue University	E. Blatchley
Seattle Community College	D. Nichols

APPENDIX D

NATIONAL ADVISORY COMMITTEE

B. B. Ashlock	Training Director, Airwork Corporation, Millville, New Jersey
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J. E. Christopher	General Aviation Specialist, Flight Standards Division, Federal Aviation Administration, Fort Worth, Texas
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A. W. Elwell	Supervisory Examination Specialist, Maintenance Technical Standards Branch, Federal Aviation Administration Aeronautical Center, Oklahoma City, Oklahoma
J. M. Fisher	Vice President, Pittsburgh Institute of Aeronautics, Pittsburgh, Pennsylvania
C. B. Gregg	Director, Technical Training and Qualifications, American Airlines, Tulsa, Oklahoma
R. H. Madeira	President, Page Aircraft Maintenance, Dothan, Alabama
H. A. Palmer	Service Manager, Vroman Aviation, Inc., Midland, Texas
H. B. Pickering	Chief, Airmen and Schools Group, Maintenance Division, Federal Aviation Administration, Washington, D. C.
H. Rosen	Assistant Director of Research, Office of Research, U. S. Department of Labor, Washington, D. C.
C. W. Schaffer	Principal Maintenance Inspector, Federal Aviation Administration, West Mifflin, Pennsylvania
J. J. Tordoff	Manager of Personnel Management, United Air Lines, San Francisco, California
Anthony Vai	Director of Aviation Maintenance Training, Northrop Institute of Technology, Inglewood, California
E. G. Willis	Chairman, Southern Region Repair Station Advisory Council, Jacksonville, Florida
Frank Woehr	Principal, Aviation High School, Long Island City, New York

Phase III

A National Study of the

AVIATION MECHANICS OCCUPATION

Curriculum & Resurvey

DAVID ALLEN, Principal Investigator

WILLIAM K. BOWERS · BERTRAM C. DRAPER · RICHARD L. LANO · JOHN M. MEYER

A Cooperative Study between the
Division of Vocational Education,
University of California, Los Angeles;
Bureau of Industrial Education,
California State Department of Education; and
U.S. Office of Education
1970

Project No. 5-0189

Vocational and Technical Education Contract OE-6-85-043

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A cooperative study between the Division of Vocational Education, University of California, Los Angeles; Bureau of Industrial Education, California State Department of Education; and the U.S. Office of Education.

UNIVERSITY OF CALIFORNIA, LOS ANGELES

August, 1970

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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INTRODUCTION

The National Study of the Aviation Mechanics Occupation had three distinct phases: Phase 1 identified a common core curriculum for the training of aviation mechanics; Phase 2 identified, through experimental research, ways to implement the common core curriculum utilizing current instructional techniques; Phase 3 had two parts, Part One involved 100 teachers from throughout the United States in curriculum development and in teacher training; and Part Two resurveyed 30 percent of the original companies studied in Phase 1. The resurvey was conducted to update the common core curriculum and to test a method by which the Federal Aviation Administration could continue to update the common core curriculum periodically with a minimum expenditure of funds. This report contains both the curriculum developed during Part One and the survey results obtained during Part Two of Phase 3 of the study. Chapters I through IV contain the results of the instructor workshop activities and Part Two (Chapter V) contains the findings of the resurvey and the recommendations of the National Advisory Committee.

PART ONE

The avaiation mechanic plays a vital part in the air transportation industry of our nation. The nature of his occupation requires that both initial training and subsequent in-service training provide him with the skills and technical knowledge necessary to perform "return-to-service" work with the highest precision and efficiency possible.

Technological advances within the aviation industry are occurring at an extremely rapid rate. These advances have created a need for additional aviation mechanics to maintain the sophisticated systems of modern aircraft. These technological advances have also made it necessary to update the instructional program currently being used in most aviation maintenance technician schools.* Thus, there were two objectives for Part One, Phase 3 of the Aviation Mechanics Occupation study:

1. To develop an updated and innovative common core curriculum based on the findings of the National Study of the Aviation Mechanics Occupation and its subsequent experimental project in curriculum development (Phase 2), and to incorporate such material into a specialized guide for instruction.

---

* Title of schools changed from "mechanic schools" to "aviation maintenance technician schools" by the FAA in their rule-change for 14CFR Part 147, referred to in this report as "FAR 147."

2. To provide teacher training for 100 teachers from Federal Aviation Administration certified aviation maintenance technician schools in order to acquaint them with emerging technical aspects of aviation and modern practices of instruction.

Ten two-week workshops were held at UCLA to achieve these two objectives. The first five workshops were concerned with the following areas of the avaiation mechanics curriculum respectively: (1) Airframe Structures, (2) Airframe Systems and Components, (3) Powerplant Theory and Maintenance, (4) Powerplant Systems and Components, and (5) General Aviation Skills. The second five workshops repeated the content of the first five. The participants of the first five workshops developed the initial curriculum materials; the participants of the second five workshops refined the materials so that only final editing by the research team was required.

The ten workshops provided an opportunity for interaction among the aviation mechanic teachers, technical advisors from the aviation industry, and members of the UCLA research team. Representatives from the FAA also participated in several of the workshops. Appendix A contains photographs of the participating teachers along with their names and schools; Appendix B contains a table displaying the workshop activities; and Appendix C contains the names of the industry representatives, their topics, and the companies they represented.

There were three major activities during each of the workshops: (1) curriculum development by the participating aviation mechanic teachers, (2) presentation of technical information about current industry practices, and (3) description and discussion of neoteric instructional techniques and media. The presentations of instructional techniques and media were made by members of the research team. The presentations were concerned with levels of instruction, student performance goals, student feedback systems, programmed instruction, multi-media instructional materials, grading, and record keeping systems. Each participant received a packet of informational materials and procedural sheets about the various techniques and media discussed to help him develop and implement those techniques and media which would be most appropriate for use at his school.

Due to the large variation among schools in both types of written materials presented and methods of integrating these materials into an instructional program, it was decided to use the format contained in this book as a model for instructors and students throughout the United States. Modifications and adaptations can easily be made which conform to the unique characteristics of each school. The format includes levels of instruction, segments of instruction, segment levels, student performance goals, key points, feedback, activities, and checkup items. Although

the format is basically designed for the instructor's use, the performance goals, feedback activities for theory instruction, and checkup items for laboratory/shop activities can be incorporated into materials given to the student.

Levels of instruction and characteristic test items for each level were thoroughly discussed in Part One of the Study of the Aviation Mechanics Occupation. Basically, levels of instruction refers to the levels of proficiency at which each subject in the curriculum must be taught. Specific skills and technical information are taught through purposeful instructional activities that are designed to help the student achieve the attainments required for successful employment. It has been found that a three-level structure is adequate in curriculum construction. The first level does not include development of manipulative skills and, therefore, requires no laboratory/shop work. This level focuses on recognition of previously learned facts and the ability to follow directions. The student must attain sufficient knowledge of relationships and associated principles to utilize the information in meaningful, job-like situations. Instruction at level 2 is concerned with the successful recall of previously learned material. The student's ability is developed to the degree that he can interpret diagrams, drawings, blueprints, tables, information in manuals, etc. The use of tools and the skills developed at this level are learned correctly; however, there is limited time devoted to skill practice. Thus, additional instruction and practice are required for the skills to become transferable. The third level focuses on the student's ability to abstract and synthesize material so that he can recognize common factors within a complex problem and draw upon many sources and types of information to formulate its solution. At this level, technical knowledge and skills are learned in sufficient breadth and depth for the student to transfer earlier learning to new sets of circumstances. The skills learned in the laboratory/shop at this level are performed efficiently and smoothly. The amount of time devoted to practice must be sufficient to provide a base for transfer of learning so that when the student is employed, he can perform productively with a minimum of additional training.

Section I of this book contains the curriculum content that was developed as a result of the ten workshops. Every attempt was made to follow the definitions in Appendix A of FAR 147. However, in a few cases it was felt that in order to better present the instructional content, a deviation from the previous definition was necessary.

There are three major curriculum divisions: General (aviation skills and technical information common to both the airframe and the powerplant license), Chapter I; Airframe, Chapter II; and Powerplant, Chapter III. The Airframe Curriculum is further divided into Airframe

Structures and Airframe Systems and Components, and the Powerplant Curriculum is divided into Powerplant Theory and Maintenance and Powerplant Systems and Components. Each of the five divisions has its own series of instructional units. Each unit title is preceded by a number printed in bold type and is followed by an instructional level number. This level number indicates the highest level of instruction designated for one or more of the segments within the instructional unit.

Immediately under each instructional unit is a suggested apportionment of time. The abbreviations are as follows: total estimated instructional time is shown as EIT; of this total time, the portion alloted to theory is shown as T and the portion alloted to laboratory/shop is shown as L/S. Following the suggested time statement is a statement indicating the number of segments included in the unit.

Each of the instructional units is subdivided into a number of segments of instruction which are denoted by capital letters. These segments are complete entities in themselves and each has its own level, which is either identical to or less than the instructional unit level.

Following each segment title with its level number is the most significant statement given concerning instructional content: the Student Performance Goal. The student performance goal describes the learning attainment that the instructor should expect from the student as an outcome of instruction. It does not state the purposes or objectives of the instructor's own teaching, but rather, identifies what technical knowledge and skill changes are expected to take place in the performance of the student as a result of the instruction provided for in the segment. The student performance goals were established to coincide with the levels of instruction which were determined by the findings and recommendations of Part I of this study and as stated in FAR 147. The instructional activities, the depth of various feedback activities, the degree of anticipated skill attainment in the laboratory/shop, and the degree of difficulty for written, oral, and performance examinations are directly related to the stated level of instruction and the student performance goal for the segment of instruction.

The student performance goal itself is made up of three major elements: the task the student will perform, how he will perform it, and the minimum standard of learning attainment that should be expected. These three elements are listed under the following three headings in the following sequence: Given, Performance, and Standard.* It should be noted that in some cases not all students will attain the stated minimum standard; in others, many studente will exceed the standard. Therefore, it is imperative that the teacher maintain a sufficient record of each student's learning patterns to make appropriate judgments concerning additional learning experiences that would help the student become successfully employed in the aviation industry.

---

* It was found that presenting the student performance goal in its three component parts (given, performance, and standard) as opposed to presenting it in the usual paragraph statement, facilitated both construction of the goal and its clear communication to the reader.

Each student performance goal is followed by two columns: the left-hand column is headed Key Points and the right-hand column is headed Feedback. The key point column contains a series of short statements that are to be used as memory joggers by the instructor in planning his instruction. No attempt is made to tell an instructor how to plan or present his lesson, rather the column suggests general areas to be covered if student performance goals and feedback items are to be achieved. The feedback column provides a suggested list of problems, questions, and discussion points that can be used during instruction to help identify how well the student has grasped the material presented. The instructor should extend this list by adding items from his own repertoire.

Segments with a level of 2 or 3 will also have a double column containing laboratory/shop activities and checkup items for these activities. The laboratory/shop column is listed on the left-hand side below the key points column and the checkup column is found below the feedback column on the right-hand side. The activities and suggested laboratory/shop experiences are appropriate for meeting the student performance goal. The checkup items are questions to assist the instructor in determining how well the student has performed the activity.

Chapter IV is concerned with the suggested instructional time for each of the segments presented in Chapters I through III. The suggested times are estimates developed by the participants from the last five workshops. The suggestions for time assignments were derived in small independent groups. However, when suggestions were compared, only very minor discrepancies between the estimations of the various groups were found. Because of this apparent consensus, the recommended time allotments for each of the segments may be considered reasonable and appropriate.

Two suggested time allotment systems are discussed in detail in Chapter IV. These are the Sequential and the Repetitive systems. The total instructional time for each of the curriculum areas is within the time frame established for the curriculum areas in FAR 147.

PART TWO

Phase 1 of the National Study of the Aviation Mechanics Occupation provided the detailed and timely information needed to bring the curriculum up to 1966 requirements. There was concern at the time that the instructional standards might remain fixed at this point instead of moving ahead with the aviation industry. Thus, the two objectives of Part Two, Phase 3, of the study were designed to assist in keeping the curriculum current with the aviation industry's requirements. These objectives were:

1. To identify changes within the industry subsequent to the original study (Phase 1 of the National Study of the Aviation Mechanics Occupation).

2. To determine the reliability of an industry "spot-check" as a means of identifying occupational change, once the occupational requirements had been inventoried and analyzed.

The techniques used in Part Two, Phase 3, were similar to those used in Phase 1. The Part Two, Phase 3 findings, the National Advisory Committee's recommendations, and the resulting levels of instruction are found in this section. It should be stressed that these findings and recommendations occurred after the levels in FAR 147 were established and should not be used until level changes are made by the Federal Aviation Administration. Part Two, Phase 3 may be used to project trends in the aviation industry.

Many individuals have made a considerable effort and contribution to the development of the curriculum content in Part One and to the presentation of data and recommendations found in Part Two of this publication. The success of any undertaking is dependent upon the many individuals who contribute to the total effort. The research team was fortunate to have so many competent and willing participants contribute to this effort. The principal investigator for the study was also fortunate to have a capable and dedicated research team that went beyond the normal expectations of its job. It is hoped that this publication will provide assistance and guidance to the many fine aviation maintenance technician schools in our nation as they plan and redirect their curriculums.

David Allen
Principal Investigator
1970

PART ONE

CHAPTER I

GENERAL CURRICULUM INSTRUCTIONAL UNITS

The General Curriculum instructional units consist of those subjects that are common to both the airframe and the powerplant license. These units should not be confused with general education subjects that are found in many school curriculums. Rather, the General Curriculum units are specific aviation technical subjects and manipulative skills that are necessary for becoming a licensed aviation mechanic.

The sequence of instructional units outlined in this report may be rearranged to more adequately meet the requirements of a particular school. In a number of schools, the General Curriculum subjects will probably be integrated with the Airframe and/or Powerplant Curriculums. Regardless of how a school revises the sequence of instructional units, the individual segments under each of the units should remain with the unit if maximum instructional impact is to be achieved.

Total time alloted for this section by FAR 147 is 400 hours. The curriculum as shown in this publication provides for 395 hours of instruction. The additional five hours may be used for review, additional practice, and/or examinations.

Schools having different instructors teaching each of the various aviation curriculums should make certain that these curriculums form a coordinated, well-organized instructional program. It is critical that the General Curriculum subjects and the practical activities are representative of the aviation industry and are not an insertion of some existing school course that is vaguely related. As in the case of the Airframe and Powerplant Curriculums, the time lag between technical instruction and laboratory/shop instruction must be kept to a minimum.

Preceding the General Curriculum instructional units in this chapter is an outline of the instructional units and their segments. The estimated time allotted for each instructional unit is also provided. Schools may make assignments for each instructional unit that are more appropriate for their requirements. It is permissible to provide time for the General Curriculum instructional units in excess of the FAR 147 requirements; however, this time should not exceed 400 hours nor should hours be exceeded in some units by reducing hours in other units. The estimated instructional hours should be sufficient to permit the student to attain the technical knowledge and manipulative skills specified by FAR 147.

There are no general non-related subjects included in the ensuing General Curriculum instructional units. Every effort was made to remove unnecessary duplication of instructional content among the General, Airframe, and Powerplant Curriculums.

The levels of instruction are consistent with FAR 147 and the student's attainment of these levels should be the prime concern of each instructor. The instructor should make every effort to assist each student in achieving the skills identified by the level. Since the instructional goals are identified, either overinstruction or underinstruction of a particular unit should be at a minimum.

OUTLINE GENERAL CURRICULUM

Instructional Units, Segments and Estimated Instructional Time

MATHEMATICS

1. EXTRACT ROOTS AND RAISE NUMBER TO A GIVEN POWER. - Level 1 3.0 hrs.

   A. **Recognize and apply formulas involving the power of a number.** - Level 1

2. DETERMINE AREAS AND VOLUMES OF VARIOUS GEOMETRICAL SHAPES. - Level 2 6.0 hrs.

   A. **Apply formulas to determine areas and volumes.** - Level 2

   B. **Compute wing area.** - Level 2

   C. **Calculate volume of baggage compartments and fuel tanks.** - Level 2

   D. **Compute piston displacement.** - Level 2

3. SOLVE RATIO, PROPORTION, AND PERCENTAGE PROBLEMS. - Level 3 5.0 hrs.

   A. **Convert fractional numbers to decimal equivalents.** - Level 3

   B. **Determine ratio and percentage of numbers.** - Level 3

   C. **Compute compression ratio.** - Level 3

4. PERFORM ALGEBRAIC OPERATIONS INVOLVING ADDITION, SUBTRACTION, MULTIPLICATION AND DIVISION OF POSITIVE AND NEGATIVE NUMBERS. - Level 3 6.0 hrs.

   A. **Add, subtract, multiply and divide positive and negative numbers.** - Level 3

Estimated Instructional Time . . . . . 20.0 hrs.

AIRCRAFT DRAWINGS

5. USE DRAWINGS, SYMBOLS AND SCHEMATIC DIAGRAMS. - Level 2 14.0 hrs.

   A. **Identify lines and symbols.** - Level 2

   B. **Interpret dimensions.** - Level 2

   C. **Interpret electrical system drawings.** - Level 2

   D. **Use installation diagrams and schematics.** - Level 2

6. DRAW SKETCHES OF REPAIRS AND ALTERATIONS. - Level 3 10.0 hrs.

   A. **Make sketches.** - Level 3

7. USE BLUEPRINT INFORMATION. - Level 3 11.0 hrs.

   A. **Read and interpret drawings.** - Level 3

   B. **Interpret installation diagrams.** - Level 3

8. USE GRAPHS AND CHARTS. - Level 3 3.0 hrs.

   A. **Use manufacturer's charts and graphs.** - Level 3

Estimated Instructional Time . . . . . 38.0 hrs.

BASIC PHYSICS

9. USE THE PRINCIPLES OF SIMPLE MACHINES: SOUND, FLUID AND HEAT DYNAMICS. - Level 2 8.0 hrs.
   - A. Relationship of temperature and heat. - Level 2
   - B. Relationships between pressure, temperature and volume of air mass. - Level 1
   - C. Factors effecting air pressure on an airfoil. - Level 1
   - D. Physical factors effecting engine output power. - Level 2
   - E. Relationship between pressure, area and force. - Level 1
   - F. The inclined plane, the level and the pulley. - Level 1
   - G. Origin of sound. - Level 1
   - H. Centrifugal/centripetal force. - Level 2

Estimated Instructional Time . . . . . 8.0 hrs.

BASIC ELECTRICITY

10. DETERMINE THE RELATIONSHIP OF VOLTAGE, CURRENT, AND RESISTANCE IN ELECTRICAL CIRCUITS. - Level 3 26.5 hrs.
    - A. Calculate current. - Level 3
    - B. Calculate voltage drop. - Level 3
    - C. Determine current carrying capacity of wire. - Level 2
    - D. Calculate electrical power. - Level 3
    - E. Measure current flow in a parallel electrical circuit. - Level 3
    - F. Demonstrate characteristics of magnetism. - Level 3
    - G. Electromagnetic induction. - Level 1
11. MEASURE VOLTAGE, CURRENT, RESISTANCE, CONTINUITY AND LEAKAGE. - Level 3 7.0 hrs.
    - A. Meaning of electrical quantity prefixes. - Level 2
    - B. Use DC electrical instruments. - Level 3
    - C. Connect voltmeters and ammeters. - Level 3
    - D. Use a voltohmmeter. - Level 3
    - E. Use ohmmeter and/or test light for open or short circuits. - Level 3
    - F. Detect electrical leakage. - Level 2
    - G. Measure AC voltages. - Level 3
12. MEASURE CAPACITANCE AND INDUCTANCE. - Level 1 4.0 hrs.
    - A. Capacitance, inductance and impedance. - Level 1
    - B. Measure capacitance in aircraft applications. - Level 1

13. CALCULATE AND MEASURE ELECTRICAL POWER. - Level 2 2.0 hrs.

  A. Determine aircraft electrical power requirements. - Level 2

14. READ AND INTERPRET ELECTRICAL CIRCUIT DIAGRAMS. - Level 3 6.0 hrs.

  A. Identify commonly used aircraft electrical and electronic symbols. - Level 3

  B. Trace circuits with aircraft wiring diagrams. - Level 3

  C. Electronic symbols and schematics in aircraft use. - Level 1

  D. Identify electrical malfunctions by reference to circuit diagrams. - Level 2

15. INSPECT AND SERVICE BATTERIES. - Level 3 10.0 hrs.

  A. Principles of battery construction and operation. - Level 2

  B. Characteristics of aircraft storage batteries. - Level 1

  C. Inspect and recharge aircraft storage batteries. - Level 3

  D. Perform removal, installation and compartment maintenance for aircraft batteries. - Level 3

16. OVERHAUL AIRCRAFT ELECTRICAL COMPONENTS. - Level 2 23.0 hrs.

  A. Basic operating principles and internal circuits of aircraft DC generators. - Level 1

  B. Locate and use overhaul information for aircraft generator repair. - Level 2

  C. Inspect and overhaul aircraft DC generator and motor. - Level 2

  D. Methods used to protect armature shafts from overload. - Level 1

  E. Design factors and control methods for aircraft AC generators. - Level 1

  F. Characteristics and operating principles of aircraft electric motors. - Level 1

  G. Check operation of a reversible motor and adjust limit switches. - Level 2

Estimated Instructional Time . . . . . 78.5 hrs.

FLUID LINES AND FITTINGS

17. FABRICATE AND INSTALL RIGID AND FLEXIBLE FLUID LINES AND FITTINGS. - Level 3 25.0 hrs.

  A. Bend aluminum and stainless steel tubing. - Level 3

  B. Perform beading of tubing. - Level 3

  C. Fabricate flares on tubing. - Level 3

  D. Fabricate and install flexible hoses. - Level 3

  E. Recognize defects in metal tubing. - Level 3

F. Install a section of tubing. - Level 3

Estimated Instructional Time . . . . . 25.0 hrs.

MATERIALS AND PROCESSES

18. PERFORM PRECISION MEASUREMENTS. - Level 3 12.0 hrs.

A. Inspect aircraft components for wear. - Level 3

19. IDENTIFY AND SELECT AIRCRAFT HARDWARE AND MATERIALS. - Level 3 38.0 hrs.

A. Identify and install aircraft bolts. - Level 3

B. Identify aluminum alloys. - Level 3

C. Identify steel alloys. - Level 3

D. Recognition of economic and engineering criteria in selection of aircraft materials. - Level 1

E. Identify rivets by physical characteristics. - Level 3

F. Identify materials used in aircraft firewalls and exhaust shrouds. - Level 2

G. Determine suitability of materials for aircraft repairs. - Level 2

H. Identify aircraft control cable. - Level 3

20. PERFORM BASIC HEAT-TREATING PROCESSES. - Level 2 6.0 hrs.

A. Effects of heat treatment. - Level 1

B. Identify aluminum alloy code designation of heat-treatability. - Level 2

C. Heat treatment processes and strain relieving. - Level 1

D. Anneal copper and steel parts. - Level 2

21. PERFORM PENETRANT, CHEMICAL ETCHING, AND MAGNETIC PARTICLE INSPECTIONS. - Level 2 12.5 hrs.

A. Perform dye penetrant inspection. - Level 2

B. Perform magnetic particle inspection. - Level 2

C. Perform inspections of welded assemblies. - Level 2

D. Perform tests to distinguish between heat treatable and weldable aluminum alloys. - Level 2

22. INSPECT AND CHECK WELDS. - Level 3 5.0 hrs.

A. Inspect and evaluate welds. - Level 3

23. IDENTIFY AND SELECT APPROPRIATE NON-DESTRUCTIVE TESTING METHODS. - Level 1 7.0 hrs.

A. Aircraft uses for non-destructive testing. - Level 1

Estimated Instructional Time . . . . . 80.5 hrs.

CLEANING AND CORROSION CONTROL

24. IDENTIFY AND SELECT CLEANING MATERIALS. - Level 3 12.0 hrs.

    A. Identify caustic cleaners. - Level 3

    B. Identify cleaning agents for aircraft engine parts. - Level 3

25. PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL. - Level 3 26.0 hrs.

    A. Clean exterior of aircraft. - Level 3

    B. Identify corrosion. - Level 3

    C. Remove corrosion. - Level 3

    D. Apply protective coatings. - Level 3

    E. Remove rust. - Level 3

    F. Clean rubber products. - Level 3

Estimated Instructional Time . . . . . 38.0 hrs.

GROUND OPERATION AND SERVICING

26. IDENTIFY AND SELECT FUELS. - Level 2 4.0 hrs.

    A. Identify aircraft fuels. - Level 2

27. START, GROUND OPERATE, MOVE, SERVICE AND SECURE AIRCRAFT. - Level 2 26.0 hrs.

    A. Use fueling equipment. - Level 2

    B. Start and operate aircraft engines. - Level 2

    C. React to fire in induction system. - Level 2

    D. Connect and operate an external hydraulic power source. - Level 2

    E. Direct the movement of aircraft. - Level 2

    F. Prepare an aircraft for outside storage. - Level 2

Estimated Instructional Time . . . . . 30.0 hrs.

MAINTENANCE PUBLICATIONS

28. SELECT AND USE FAA AND MANFACTURER'S AIRCRAFT MAINTENANCE SPECIFICATIONS, DATA SHEETS, MANUALS, PUBLICATIONS AND RELATED FEDERAL AVIATION REGULATIONS. - Level 3 13.0 hrs.

    A. Locate reference data. - Level 3

    B. Use information from the aircraft specifications. - Level 3

    C. Use information from the manufacturer's manuals to verify control surface travel. - Level 3

    D. Identify and relate regulations governing airworthiness certificates. - Level 3

    E. Select and use technical standard orders. - Level 3

F. Use manufacturer's manuals and other publications. - Level 3

G. Select and use supplementary type certificates and airworthiness directives. - Level 3

29. READ TECHNICAL DATA. - Level 3 6.0 hrs.

A. Read, understand and relate technical information. - Level 3

Estimated Instructional Time . . . . . 19.0 hrs.

MECHANIC PRIVILEGES AND LIMITATIONS

30. EXERCISE MECHANIC PRIVILEGES WITHIN THE LIMITATIONS PRESCRIBED BY FAR 65. - Level 3 5.0 hrs.

A. Interpret FAR 65. - Level 1

B. Classify aircraft repairs. - Level 3

C. Interpret regulations governing repairs and alterations. - Level 3

D. Interpret repair station regulations. - Level 1

E. Recognize legal and ethical responsibilities. - Level 1

Estimated Instructional Time . . . . . 5.0 hrs.

MAINTENANCE FORMS AND RECORDS

31. WRITE DESCRIPTION OF AIRCRAFT CONDITION AND WORK PERFORMED. - Level 3 5.0 hrs.

A. Inspect an aircraft and prepare a condition report. - Level 3

B. Write a description of major/minor repairs and routine maintenance.

32. COMPLETE REQUIRED MAINTENANCE FORMS, RECORDS, AND INSPECTION REPORTS. - Level 3 8.0 hrs.

A. Make maintenance record entries. - Level 3

B. Use inspection guides. - Level 3

C. Evaluate aircraft records for compliance with Federal Air Regulations. - Level 3

Estimated Instructional Time . . . . . 13.0 hrs.

WEIGHT AND BALANCE

33. WEIGH AIRCRAFT. - Level 2 13.0 hrs.

A. Locate, interpret and apply weight and balance information. - Level 2

34. PERFORM COMPLETE WEIGHT AND BALANCE CHECK AND RECORD DATA. - Level 3 27.0 hrs.

A. Solve weight and balance problems. - Level 3

B. Compute forward and aft loaded center of gravity. - Level 3

C. Compute effect of equipment changes and loading schedules. - Level 3

D. Compute weight and balance on a helicopter. - Level 3

E. Examine weight and balance records. - Level 2

Estimated Instructional Time . . . . . 40.0 hrs.

Total Estimated Instructional Time . . . . 395.0 hrs.

Additional Practice and/or Examinations . . . . . 5.0 hrs.

Grand Total for General Curriculum . . . . 400.0 hrs.

MATHEMATICS

1. EXTRACT ROOTS AND RAISE NUMBERS TO A GIVEN POWER. (EIT = 3 hrs., T = 3 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

RECOGNIZE AND APPLY FORMULAS INVOLVING THE POWER OF A NUMBER.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Ten mathematical formulas that involve numbers raised to powers (AREA = πR^2, etc.) and an appropriate mathematics text or information sheet.

- Performance:
  The student will recognize formulas that contain exponents. Using the reference information as a guide, he will solve five problems requiring the application of the formulas.

- Standard:
  The student will apply the correct formula. Solution of problems will demonstrate arithmetic accuracy to a two-place decimal.

Key Points	*Feedback*
Squaring and cubing whole numbers. ($A^2 + B^2 = C^2$, etc.)	•Describe two examples of work situations that would require the squaring of a number. •What would be meant if a technical report described "the square of velocity"?
Squaring and cubing decimals ($.02^2$) etc.	•If a decimal value is "squared," will the resultant be greater or less than the original value? •If a whole number is raised to a power of two, will the product have a greater value or a value less than the original number?
Squaring and cubing fractions ($\frac{1}{4}^2$) etc.	•If a fraction is cubed, will the product have a value greater or less than the original fraction?
Extracting square root from a table.	•Describe some work situations in which a mechanic would be required to extract square root. •Describe the parts of the square root table and how they relate. •What precautions should be taken in order to use the square root table accurately?
Extracting square root by mathematics.	•Discuss the procedure for solving square root. •What does reciprocal mean and how is it used with a square root table? •How is a number divided prior to having its square root extracted mathematically? •How is an extracted square root checked for accuracy?

2. DETERMINE AREAS AND VOLUMES OF VARIOUS GEOMETRICAL SHAPES. (EIT = 6 hrs., T = 4 hrs., L/S = 2 hrs.) 4 segments

(UNIT LEVEL 2)

APPLY FORMULAS TO DETERMINE AREAS AND VOLUMES.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Formulas and information sheets containing dimensioned drawings of rectangles, squares, triangles, trapezoids, circles, cylinders, cones, cubes, etc.

- Performance:
  The student will apply the correct formula and determine the area and/or volume of ten different geometrical shapes.

- Standard:
  The formula selected will be the correct formula. The arithmetic solution of the problem will be accurate to a two-place decimal.

Key Points	*Feedback*
Area formulas.	•Describe a circumstance in which a mechanic would be expected to compute area. •Explain why the included angles of a triangle are not related to the calculation of area. •What is meant by the expression "r^2" in the formula for calculating the area of a circle? •Explain how the formulas may be applied to the calculation of area of a square, rectangle or parallelagram. •What features identify a trapezoid? When computing area, could a trapezoid be divided into equivalent geometrical shapes?

Volume formulas.	•Describe the circumstances under which a mechanic will compute volumes. •What features permit the identification of a cone and a cylinder? •What procedures could be followed to determine the volume of a fuel tank? An irregularly shaped reservoir?

Activities	*Check Items*
	Did the student:
Apply the correct formulas and solve ten problems.	•Select the correct formula? •Achieve desired mathematical accuracy?

COMPUTE WING AREA.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
An information sheet illustrating the shapes and dimensions of two aircraft wings and the formulas for determining the area of various geometrical shapes.

- Performance:
The student will apply the correct formula and compute the total wing area.

- Standard:
The student will select and apply the correct formulas. Computation of total wing area will be accurate to the nearest square foot.

Key Points	*Feedback*
Dimensioning of wings.	•Why are wings dimensioned in inches but wing areas are expressed in square feet? •How does a mechanic convert square inches to square feet? •If the cord dimension of the wing root is known and the chord dimension of the wing tip is specified, how may a mechanic determine the mean chord?
Applying area formulas to wing planforms.	•Explain why the area of the ailerons and flaps may or may not be included in the total wing area. •What measurements would be necessary in order to calculate the area of a flap or an aileron? •Explain the aerodynamic effect of flaps, slats, slots and other high lift devices upon the calculation of wing area. •What effect does sweepback have on wing area?

Activities	*Check Items*
	Did the student:
Apply formulas and compute total area for two wings illustrated on information sheet.	•Select and apply the correct formula? •Achieve desired arithmetic accuracy?

CALCULATE VOLUME OF BAGGAGE COMPARTMENTS AND FUEL TANKS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
Formulas for determining the volume of various geometrical shapes and an information sheet containing dimensioned drawings for an aircraft baggage compartment and an aircraft fuel tank.

- Performance:
The student will select and apply the correct formulas and compute the volume of the baggage compartment and fuel tank.

- Standard:
The student will select and apply the formulas without error. Computation of volumes will be accurate to the nearest cubic foot and/or U.S. gallon.

Key Points	*Feedback*
Units of measurement applicable to volumes.	•Why would the dimensions of a cargo or baggage compartment be measured in inches but the capacity of the compartment be expressed in cubic feet? •What unit of measurement would describe the volume of the main cabin? (i.e., cubic feet or cubic inches?) •What unit of measurement is used to describe the output of a pump? A ventillation fan?

	•What volumetric unit of measurement is used to describe the capacity of a fuel tank?
Conversion of volume to standard units of measurement.	•How does a mechanic convert cubic inches into cubic feet? •If a computation of volume results in an answer expressed in cubic inches, how is this answer converted to U.S. gallons?

Activities	*Check Items* Did the student:
Compute volume of a baggage compartment.	•Select and apply the correct formulas?
Compute volume of a fuel tank and express volume in U.S. gallons.	•Achieve desired arithmetic accuracy?

COMPUTE PISTON DISPLACEMENT.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  The formula for computing the volume of cylinders and information specifying the bore, stroke and number of cylinders on a typical aircraft engine.
- Performance:
  The student will compute the piston displacement of the engine.
- Standard:
  The computed displacement of the engine will be accurate to one cubic inch.

Key Points	*Feedback*
Definition of bore, stroke and number of cylinders.	•Why do some engine manufacturers use the engine displacement as a part of the engine model designations? (i.e., Wright 1820, Continental 0–470, etc.) •Explain why the displacement as indicated by the model designation may not *exactly* equal the computed engine displacement. •How is the number of cylinders related to the displacement of an engine?
Cylinder dimensions.	•Why is the bore and stroke of an engine rarely an even dimension of an inch? (i.e., bore = 4.125 inches; stroke = 4.685 inches.) •What unit of measurement is used to express the dimension of a cylinder? •Why isn't the displacement of an engine expressed in cubic feet?

Activities	*Check Items* Did the student:
Compute displacement of an engine.	•Correctly apply the formula? •Achieve desired arithmetic accuracy?

3. SOLVE RATIO, PROPORTION, AND PERCENTAGE PROBLEMS. (EIT = 5 hrs., T = 3 hrs., L/S = 2 hrs.) 3 segments

(UNIT LEVEL 3)

CONVERT FRACTIONAL NUMBERS TO DECIMAL EQUIVALENTS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  An information sheet, illustrating a scale of each 1/32 inch graduation, from 1/32 inch to one inch.
- Performance:
  The student will, without reference to charts or other aids, arithmetically convert 10 fraction scale graduations to a decimal equivalent.
- Standard:
  Each decimal equivalent will be accurate to three places (thousandths).

Key Points	*Feedback*
Conversion of fractions to decimals and vice versa.	•Why are dimensions appearing on older aircraft drawings expressed as fractional measurements? •Why are precision parts usually dimensioned by decimal measurements? •Why must a mechanic be able to convert fractions to decimals and vice versa?

	•What arithmetic procedure is necessary in order to add, subtract, multiply, and divide fractional and decimal values? •What aids generally are used by a mechanic in order to convert fractional numbers to decimal numbers? •What is meant by the term, accurate to two-decimal places?

Activities	*Check Items* Did the student:
Convert each 1/32 inch graduation to a decimal equivalent.	•Achieve the desired accuracy? •Recognize that each decimal value was a multiple of the base .03125

DETERMINE RATIO AND PERCENTAGE OF NUMBERS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An information sheet displaying three dimensioned diagrams or drawings of wing aspect ratio, fineness ratio of streamlined shapes, major and minor axes of an ellipse, etc.

- Performance:
  The student will determine the ratio of one number or dimension to the other. When expressed as a ratio, he will determine the percentage that one number is of the other.

- Standard:
  The student will determine the ratios and percentages of the dimension for two of the illustrations on the information sheet. The determination of percentages will be accurate to a three-place decimal.

Key Points	*Feedback*
Ratio of numbers.	•In what sequence or order is a ratio of two numbers expressed? •How does a ratio relate to proportion? (i.e., What is the difference between an aspect ratio of 8 and an expression 1:8?)
Percentage of numbers.	•If an engine rated at 1000 horsepower is operating at 825 horsepower, what is the percentage of power being developed? •If an engine is to be operated at 70 percent power and it is rated for 230 horsepower, how much power is developed during normal operation? •If a maximum take-off weight exceeds the maximum landing weight by 105%, how could a mechanic determine the maximum authorized landing weight? •An airplane with a total useable fuel supply of 130 gallons consumes 23 gallons per hour at cruise power. What percentage of the total available fuel is consumed per hour? •If a streamlined body has a fineness ratio of five, what is the percentage of width to length?

COMPUTE COMPRESSION RATIO.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  A sketch or drawing of a cylinder and piston assembly with stated volumes of the cylinder when the piston is at bottom center and at top center.

- Performance:
  The student will determine the compression ratio of the cylinder.

- Standard:
  The compression ratio will be computed to an accuracy of one decimal place.

Key Points	*Feedback*
Compression ratio.	•Why is it necessary for a mechanic to know the *volume* of the cylinder with the piston at BDC and TDC in order to determine a compression ratio? •As a ratio is a relation between two numbers, what factors indicate which number will be regarded as the divisor?

	•If a ratio involves fractional numbers, why are they reduced to a common denominator?

Activities	*Check Items* Did the student:
Determine compression ratio from specified volumes.	•Achieve desired accuracy in computation?

4. PERFORM ALGEBRAIC OPERATIONS INVOLVING ADDITION, SUBTRACTION, MULTIPLICATION AND DIVISION OF POSITIVE AND NEGATIVE NUMBERS. (EIT = 6 hrs., T = 3 hrs., L/S = 3 hrs.) 1 segment

(UNIT LEVEL 3)

ADD, SUBTRACT, MULTIPLY AND DIVIDE POSITIVE AND NEGATIVE NUMBERS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Information sheets containing dimensioned weight and balance diagrams, illustrating datum, mainwheel, nose/tail wheel, and center of gravity positions and moment arms.

- Performance:
  The student will algebraically label each of the dimensions with a plus or minus sign. He will solve twenty problems involving addition, subtraction, multiplication and division of these signed numbers.

- Standard:
  Labeling and computations will be without error.

Key Points	*Feedback*
Signed (+ & −).	•Describe a condition in which signed numbers are used to express temperature? •How might signed numbers be used to express elevations above and below sea level? •Illustrate how signed numbers are used to indicate positions relative to a datum in weight and balance diagrams. •Illustrate how signed numbers could indicate the installation and removal of weights in weight and balance computations.
Algebraic significance of signed numbers.	•With reference to a weight and balance computation, why does the multiplication of a minus weight times a minus arm result in a plus moment? •Why does the multiplication of a minus times a plus result in a minus? •When differently signed numbers are added, what sign is given to the sum? •When plus and minus numbers are subtracted, what procedure must be followed;

Activities	*Check Items* Did the student:
Solve twenty problems requiring the addition, subtraction, multiplication and division of signed numbers.	•Correctly assign values to the diagram? •Achieve desired accuracy?

AIRCRAFT DRAWINGS

5. USE DRAWINGS, SYMBOLS, AND SCHEMATIC DIAGRAMS. (EIT = 14 hrs., T = 7 hrs., L/S = 7 hrs.) 4 segments

(UNIT LEVEL 2)

IDENTIFY LINES AND SYMBOLS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Reference information that illustrates and describes outline, hidden, phantom, section, center and dimension lines and copies of typical aircraft detail and assembly drawings.
- Performance:
  The student will recognize and identify each kind of line as it appears in the drawings. He will interpret the meaning of the lines as they relate to surfaces and details of the part represented by the drawing.
- Standard:
  The student will point to one example of each type of line on the drawing and describe the detail of the part that is represented by that line. He will observe normal precautions and care for the drawings.

Key Points	*Feedback*
Purpose of drawings.	•What are assembly drawings? •What is the difference between a detail drawing and an assembly drawing? •How would the location of a component part be illustrated on an assembly drawing? •What symbols may be used on drawings or diagrams to illustrate the location of sub-assemblies? •How may a line diagram illustrate the location of parts within the airplane or in a system?
Kinds of lines.	•Describe the generally established standard for the use of lines on drawings. For example, what is understood by a "broken" line? What is meant when the line is solid? •What characteristics identify a dimension line? How are extension lines used with dimension lines? •How would a mechanic recognize a section line and the associated auxiliary or "sectioned" view? •What is the purpose of a "break" line? •What symbol is commonly used to identify a section or auxiliary view if there is more than one auxiliary view presented on the drawing?

Activities	*Check Items* Did the student:
Recognize and identify lines and symbols on drawings.	•Correctly identify each kind of line and symbol and relate them to surfaces and details of the part? •Use correct nomenclature as part of the explanation? •Recognize the standard symbols used in sectioned and auxiliary views?

INTERPRET DIMENSIONS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Typical aircraft detail drawings, dimensioned in accordance with standard industry practice.
- Performance:
  The student will locate and interpret any dimension appearing on the drawing, including the application of any limits or tolerance to the dimension.
- Standard:
  Dimensions will be promptly located and interpreted without error.

Key Points	*Feedback*
Dimensioning standards.	•Describe and illustrate continuous line dimensioning. Where is this method used and what is the advantage? •What is the purpose of centerline dimensioning and where is this method used? •Illustrate and describe where progressive base line dimensioning would be used.

	•What unit of measurement is applied to the dimensions appearing on aircraft drawings? •Describe why a drawing should not be measured as a means of determining an unknown dimension.
Limits and tolerances.	•What is a "nominal" dimension? •Where would information describing the tolerances be located on the drawing? •What is understood by the expression "plus-or-minus"? •How can an accumulation of tolerances be detrimental to the assembly or fit of mating parts?

Activities	*Check Items* Did the student:
Interpret dimensions on aircraft drawings.	•Promptly locate and correctly interpret every dimension on the drawing? •Correctly apply tolerances to dimensions?

INTERPRET ELECTRICAL SYSTEM DRAWINGS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A diagram or drawing of an electrical system that contains at least five individual circuits.

- Performance:
  The student will locate, isolate and extract specific circuits from the diagram. He will trace specifically identified circuits.

- Standard:
  The student will correctly extract three individual circuits from the system diagram.

Key Points	*Feedback*
Kinds of electrical drawings.	•In what ways does a schematic differ from an actual drawing? •How are electrical components identified in electrical circuit diagrams? •How can an individual circuit be isolated from a drawing and located in the airplane? •How can the size of wire required for a particular circuit be specified on the drawing? •How can the part number of an electrical component be determined?

Activities	*Check Items* Did the student:
Isolate three individual circuits in the system diagram.	•Promptly locate and identify the circuits? •Correctly interpret information applicable to an individual circuit?

USE INSTALLATION DIAGRAMS AND SCHEMATICS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  Installation drawings or schematic diagrams of three specific systems (fuel, oil, hydraulic, pressurization, etc.) and the maintenance manual for the airplane.

- Performance:
  The student will recognize the symbols and interpret information pertaining to identification and location of components within the system.

- Standard:
  The student will describe the location and name all of the components in two of the three system drawings.

Key Points	*Feedback*
Diagrams and schematics.	•What is the purpose of a schematic? •What is the advantage of a diagram or schematic to illustrate a complete system? •How could the hydraulic pressure source be represented in a schematic? •What benefit could be gained by using a schematic of the pitot-static system?
Analysis of system.	•Why is it important that schematics be read in proper sequence, i.e., source, separate segments, control, distribution points, etc.?

	•Why is it important that a mechanic follow a procedure of "first things first" when analyzing systems for malfunctions?

Activities	*Check Items* Did the student:
Read symbols and interpret information from diagrams. Describe the location and name all the components in two of the drawings.	•Correctly locate and apply information from the maintenance manual? •Use correct nomenclature?

6. DRAW SKETCHES OF REPAIRS AND ALTERATIONS. (EIT = 10 hrs., T = 4 hrs., L/S = 6 hrs.) 1 segment

(UNIT LEVEL 3)

MAKE SKETCHES.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Appropriate drafting equipment and three written reports describing major repairs or alterations to the structure of the airplane.

- Performance:
  The student will make three sketches or drawings illustrating major repairs or alterations.

- Standard:
  The sketches or drawings must conform to standard drafting procedures, including correct position of views, adequate dimensions and specification of materials. The sketches or drawings will be of such quality that they could be used as part of the maintenance records of an airplane.

Key Points	*Feedback*
Pictorial sketching.	•What factors dictate the appropriateness of a sketch as compared to a three-view drawing? •In what respect is an oblique sketch similar to an isometric presentation? •How do perspective sketches differ from oblique and isometric sketches? •Under what conditions would pictorial presentations be preferred to three-view orthographic drawings?
Orthographic projections.	•What factors dictate the number of views that should be used in an orthographic projection? •What is the value of sectioned or auxiliary views? •What significance is attached to the selection of the "front, top and right-end" view of a part? •What is the standard practice regarding "revolution" of views?

Activities	*Check Items* Did the student:
Make 3 sketches or drawings illustrating a major repair or alteration.	•Evaluate the appropriateness of a sketch vs. a three-view drawing? •Include all necessary dimensions and material specifications as a part of the sketch or drawing?

7. USE BLUEPRINT INFORMATION. (EIT = 11 hrs., T = 5 hrs., L/S = 6 hrs.) 2 segments

(UNIT LEVEL 3)

READ AND INTERPRET DRAWINGS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Random copies of aircraft drawings that were drawn to various scales, incorporate different title blocks and changes from the original drawing.

- Performance:
  The student will read and interpret information.

- Standard:
  When provided with a list of ten questions pertaining to scale, title block information and changes incorporated on the drawings, the student will correctly answer seven of the questions.

Key Points	*Feedback*
Scale of drawings.	•What is meant by the term "full scale"?

	•What is the advantage of drawings that are drawn to enlarged or reduced scale? •Why isn't it possible to measure a full scale drawing rather than locating the dimensions shown on the drawing?
Title block information.	•Is there any universal type of title block used for aircraft drawings? •Where is the drawing number shown on a drawing? •Under what conditions might the next higher assembly number appear on a drawing? •Where will the name of the part appear on a drawing? •Where will specifications pertaining to required heat treatment appear on a drawing? •Where does information specifying the finish on the part appear? •Where will the material specifications be shown on a drawing?
Changes to drawings.	•How are changes noted on an original drawing? •How can a mechanic ensure that he is working from a current drawing? •If a change on a drawing is limited to a few specific details, how can a mechanic identify those specific changes?

Activities	*Check Items* Did the student:
Read and interpret information from blueprints.	•Correctly answer the questions requiring interpretation of information appearing on the drawings?

INTERPRET INSTALLATION DIAGRAMS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Installation diagrams or drawings of the type usually associated with Service Bulletins, modifications or Airworthiness Directives.

- Performance:
  The student will interpret the information necessary to comply with the modification and will describe the procedure required to comply with the publication.

- Standard:
  The student will use correct nomenclature when describing procedure and will interpret all drawings relating to location of equipment, etc. without error.

Key Points	*Feedback*
Service bulletins.	•Why are installation diagrams or drawings a common method of illustrating required changes or modifications? •Why may drawings supplied with service bulletins not incorporate dimensions? •If a service bulletin specifies the installation of a component at a particular station of the airplane, how is the location established?
Engineering and/or service changes.	•Why are both part numbers and serial number ranges important when identifying parts that are to be modified? •What relationship exists between information appearing on the drawing and the following processes: a. Line ream? b. Press fit? c. Six rivets, equally spaced d. Remove burr? e. Blend radius?

Activities	*Check Items* Did the student:
Interpret installation diagrams.	•Correctly establish the location of equipment to be installed? •Use correct nomenclature to describe the procedure for compliance with a service letter? •Correctly identify by serial number those parts requiring modification?

8. USE GRAPHS AND CHARTS. (EIT = 3 hrs., T = 1 hr., L/S = 2 hrs.) **1 segment**

(UNIT LEVEL 3)

USE MANUFACTURER'S CHARTS AND GRAPHS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Charts and graphs of the type that appear in manufactuere's service and operating manuals.

- Performance:
  The student will read, interpret, and apply data obtained from an engine power or performance chart.

- Standard:
  Plotting of information contained in the chart will be accurate within a 10 percent tolerance.

Key Points	*Feedback*
Kinds of graphs or	•What is a line graph? •How could a bar graph be used in presenting comparative data? •Why is information often presented in graph or chart form when it could be written in narrative?
Interpreting graphs or charts.	•Why must the titles and notes be read before attempting to interpret a chart? •What is the difference between interpreting and interpolating a chart or graph? •What degree of accuracy is reasonable when interpreting a chart or graph?

Activities	*Check items*
	Did the student:
Read and interpret information from a powerplant performance chart.	•Determine power available at altitude when manifold pressure, RPM and temperature were given? •Determine fuel consumption at specified altitudes and power? •Determine sea level power available when temperature manifold pressure and RPM were stated?

9. USE THE PRINCIPLES OF SIMPLE MACHINES: SOUND, FLUID, AND HEAT. (EIT = 8 hrs., T = 6 hrs., L/S = 2 hrs.) 8 segments

(UNIT LEVEL 2)

RELATIONSHIP OF TEMPERATURE AND HEAT.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Written text material, line sketches illustrating three methods of heat transfer without title or labels, and descriptions of heat transfer applications in aircraft.
- **Performance:**
  The student will explain the relationship between temperature and heat. He will identify and label three methods of heat transfer and list two examples of where each is applied in an aircraft.
- **Standard:**
  All of the diagrams will be correctly labeled. Explanations will be in accordance with text provided. At least four examples of applications will be correctly listed.

Key Points	*Feedback*
Define heat and temperature.	• Explain specific heat of a substance. • What is the difference between heat and temperature? • What amount of work (in foot-pounds) can be produced by the heat energy of one BTU?
Thermal energy transmission.	• What causes conduction of heat through a metal rod? • What are the three methods of heat transference?

Activities	*Check Items* Did the student:
Identify in sketches, heat transfer by conduction, radiation and convection.	• Use correct nomenclature?
Give examples of heat transfer aboard an aircraft.	• Label the three methods of heat transfer?

RELATIONSHIPS BETWEEN PRESSURE, TEMPERATURE AND VOLUME OF AIR MASS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Appropriate written reference material and questions concerning the relationships between pressure, volume, and temperature of an air mass.
- **Performance:**
  The student will write answers to ten questions about relationships between pressure, volume and temperature of an air mass and some of the resultant effects in operation of aircraft.
- **Standard:**
  At least seven correct answers.

Key Points	*Feedback*
The Law of Gasses.	• What happens to the pressure and temperature of a confined gas when the volume is changed by increasing or decreasing the size of the container? • What happens to the temperature of a gas when it is: a. compressed? b. allowed to expand?
Atmosphere.	• To what extent does the general gas law apply to the air of the atmosphere? • Why must the effects of humidity be considered when applying the gas law relationship to aircraft operations? • How can the general gas law be applied to the pressure and temperature changes that occur with changes of altitude?
Effects on aircraft occupants.	• How can the feeling of increasing warmth and ear discomfort during unpressurized descent in an airplane be explained by the gas law?

	What changes in outside temperature and pressure are normally encountered as an airplane ascends?
Applications to aircraft engines.	What happens to the pressure and temperature of a confined gas in a cylinder when volume is decreased by an upward stroke of the piston? What happens to the pressure when the temperature is increased, while volume is held practically constant at start of combustion? Compare this with what happens in a turbine engine as to relative pressure and volume changes when air is compressed by the compressor – then temperature is increased by combustion.
Applications to cabin air conditioning.	What happens to the temperature of outside air when it is forced into the cabin by an airpump or compressor? What happens to the temperature when the same air is expanded in volume as it enters the cabin? Will an airplane with cabin pressurization need more or less air heating capability than a non-pressurized airplane? Why are there no heaters in a modern jet aircraft?

FACTORS EFFECTING AIR PRESSURES ON AN AIRFOIL.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- Given:
  Reference text, unlabeled line drawings illustrating air flow around an airfoil and multiple choice questions about airfoil lift.

- Performance:
  The student will add labels and arrows to show the relationship of air velocities and pressures acting on the upper and lower surfaces of an airfoil, and will select correct answers for ten questions concerning the causes of lift by airflow over an airfoil and the effects on the lift by changes in atmospheric temperature and humidity.

- Standard:
  At least 70 percent of labels and arrows on drawings correct and select correct answers to seven questions.

Key Points	*Feedback*
Airflow pattern over an airfoil.	What is the difference in velocity of airflow on the upper and lower surfaces of an airfoil? Why is the airflow velocity different?
Effect on air density.	What happens to pressure at the point where velocity is the greatest?
Bournelli's principle.	Describe a Venturi tube. What happens to the pressure on the upper surface of an airfoil when velocity is increased?
Relationship of air density to temperature and humidity.	How does temperature increase or decrease effect air density? How does change in density of the air effect the lift of an airfoil?
Effect of temperature and humidity changes.	How then does an increase in air temperature accompanied by an increase in humidity effect the takeoff of an airplane?

PHYSICAL FACTORS EFFECTING ENGINE POWER OUTPUT

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  Reference material including engine performance data and power curves, questions relating to work, force, and power and a problem in determination of engine power output.

- Performance:
  The student will answer ten questions dealing with work, force, time, distance and power as they relate to aircraft engine power output and solve a problem to determine the effect of air density on power output using a given power curve and specified temperature and humidity.

- Standard:
  Correct answers for at least seven questions and power output determination within ten percent.

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Key Points	*Feedback*
Define work.	• Describe how force and distance are used to determine work. • What is the unit used to measure work?
Define power.	• Describe how force and distance and time are used to determine power. • What are the units used to measure: a. Power? b. Mechanical power? c. Electrical power?
Density of the air.	• How does temperature increase or decrease effect air density? • What effect does moisture have on air density?
Effects of air density on engine power.	• How does the temperature effect on the density of the air, effect power output? • How does the humidity effect on the density of air effect power output? • How does the pressure change at altitude effect the density of the air? • What is the effect on power output?

Activities	*Check Items* Did the student:
Read and interpret power chart in an engine performance manual.	• Use correct nomenclature?
Solve problems using power curves.	• Accurately determine power available when altitude and variations in temperature and humidity were given?

RELATIONSHIP BETWEEN PRESSURE, AREA AND FORCE.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- Given:
  Written reference information and two diagrams without labels or direction arrows.

- Performance:
  The student will indicate in a diagram the relationship between pressure, area, and force as applied to the transmission of power in a hydraulic system. He will explain by arrows and label a diagram which illustrates the relationship between pressure and the rate of flow of liquid through an orifice.

- Standard:
  Not more than one error in each diagram.

Key Points	*Feedback*
Computations of pressure, force and area.	• What is the unit of measurement for pressure in the United States? • How may the pressure be determined if the force and area are given? • How may force be computed if the pressure and area are given? • How may area be determined if the pressure and force are given?
Incompressibility of liquids.	• Why is liquid said to be incompressible? • Explain how mechanical advantage is obtained in a simple hydraulic system. • What are the effects of friction on hydraulic fluid flowing under pressure?

THE INCLINED PLANE, THE LEVEL AND THE PULLEY.

(SEGMENT F, LEVEL 1)

Student Performance Goal

- Given:
  Sketches without labels of simple machines, illustrating the inclined plane, the lever, and the pulley.

- Performance:
  The student will label the sketches. He will indicate the effect of resistance, friction, efficiency and mechanical advantage by arrows and descriptive notes.

- Standard:
  Three of the four sketches will be labeled without error.

Key Points	*Feedback*
Simple machines.	• What determines the efficiency and mechanical advantage of a lever? • What factors influence the efficiency of a wedge?

	•What factors dictate the efficiency of a wheel? •What factors influence the mechanical advantage of a pulley?

ORIGIN OF SOUND.

(SEGMENT G, LEVEL 1)

Student Performance Goal

- **Given:**
  Reference text material and sketches of origin, propagation and control of sound.

- **Performance:**
  The student with reference to the sketches, will write brief explanations of:
  a. Temperature effect on speed of sound.
  b. Origin of sound (vibration) and resonance ("beat").
  c. Sympathetic vibration and reflection of sound waves.
  d. Methods of control and reduction of excessive sound.
  e. Methods of protection, against excessive sounds.

- **Standard:**
  Of five explanations, four must be in accord with the given reference material.

Key Points	*Feedback*
Sound propagation.	•Name several methods by which sound is created or propagated. •How is sound transmitted through any medium? •How is sound detected by the human ear?
Protection against excess of sound.	•How do ear plugs accomplish reduction of sound in the ear? •How effective are they? •How do ear muffs accomplish reduction of sound reaching the eardrums? •How effective are ear muffs? •How important is ear protection to the people who work around aircraft?
Sound speeds	•Explain what is meant by the terms: a. Subsonic. b. Sonic. c. Transonic. d. Supersonic.
Creation of sound.	•How is sound created by the movement of a propeller blade through air? •How is sound created at the inlets and outlets of turbine engines?
Measurement, control, and reduction of sound levels.	•What is meant by a perceived DB level of sound? •How can baffles and sound chambers reduce high levels of sound?

CENTRIFUGAL/CENTRIPETAL FORCE.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- **Given:**
  Reference information and an unlabeled diagram.

- **Performance:**
  The student will illustrate the two forces acting on a body in circular motion. He will label the diagram and add arrows to show centrifugal and centripetal force, linear and angular velocity.

- **Standard:**
  Diagram to have at least four labels and four arrows correct.

Key Points	*Feedback*
Newton's law of motion.	•Give three examples of centrifugal force acting on parts of an airplane. •What is the centrifugal effect if the speed of a rotating body is increased?
Angular velocity.	•If the weight of a rotating body is increased, what is the effect on the centrifugal force? •What is the relationship of centrifugal to centripetal force?

Activities	*Check Items* Did the student:
Label a diagram to illustrate centrifugal/centripetal force.	•Use correct nomenclature?

10. DETERMINE THE RELATIONSHIP OF VOLTAGE, CURRENT, AND RESISTANCE IN ELECTRIC CIRCUITS. (EIT = 26½ hrs., T = 14 hrs., L/S = 12½ hrs.) 7 segments

(UNIT LEVEL 3)

CALCULATE CURRENT.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  An electrical series circuit having a lamp, a battery, rheostat, and a voltohmmeter.
- Performance:
  The student will measure the resistance of the rheostat at a selected setting, voltages at the battery, the lamp, and the rheostat, and will calculate the current flow through the lamp.
- Standard:
  The student will calculate and measure without error within the accuracy of the meter used.

Key Points	*Feedback*
Review basis of electricity.	•Explain the electron theory. •In terms of analogy, define voltage, current and resistance. •Given any two elements of Olm's law triangle, find the third.
Ohm's law.	•What happens to current flow when resistance is increased, with voltage remaining constant? •What happens to resistance when the voltage or current is changed?
Review meter fundamentals.	•Name the three types of meters which correspond to the Ohm's law triangle. •Which type of meter is basic to the other two? •What is a galvanometer?
Meter scales.	•What is meant by interpolation? •How is parallax error avoided? •What factors contribute to meter inaccuracy? •Name some advantages of multimeters compared to single purpose meters.
	•What kinds of measurement are generally provided by a voltohmmeter?
Connecting meters.	•To what extent does the integrity of the connection effect the meter reading? •What are the methods for connecting voltmeters, ohmmeters and ammeters?

Activities	*Check Items* Did the student:
Connect meter.	•Properly connect meter for measuring voltage, resistance and current?
Select mode and function.	•Use mode and function appropriate for check being performed?
Determine and select proper ranges.	•Select the range in a manner which protects the meter?
Read multimeter.	•Read pertinent scales and interpolate accurately? •Use multiplier factors to arrive at correct value for reading?
Calculate current.	•Apply Ohm's law to calculate current through a load, from measurements of the resistance and voltage drop of a rheostat in series with the load?

CALCULATE VOLTAGE DROP.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  A battery, electrical wire, and five different color coded resistors of various tolerances.
- Performance:
  The student will hook up and read the current flow through each resistor, calculate the voltage drop across each resistor and check his answers with a voltmeter.
- Standard:
  Calculate the voltage drop correctly for five resistors and read meters without error within the accuracy of the meters used.

Key Points	*Feedback*
Color codes for resistors.	•What do the first three color bands indicate? •How is a resistor color coded for tolerance? •How is wattage determined?
Ammeter use.	•How is the ammeter connected to read current flow through a resistor?
Ohm's law calculations applied to resistors.	•How is the voltage drop across the resistor calculated if current and resistance is known? •What is the accuracy of the calculation dependent upon? •How is a voltmeter used to check the voltage drop across a resistor? •To what extent will the ohms per volt resistance of the voltmeter effect the accuracy of the reading?

Activities	*Check Items*
	Did the student:
Connect an ammeter in a circuit and read current flow.	•Correctly connect the ammeter? •Read current measurement with correct decimal point position?
Interpret resistor color code.	•Record resistance value with correct decimal point position?
Calculate voltage drop across a resistor.	•Use correct Ohm's law formula?
Connect and read voltmeter.	•Connect the voltmeter correctly? •Read voltage accurately?

DETERMINE CURRENT CARRYING CAPACITY OF WIRE.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  Aircraft wire, a battery, adjustable resistor, electrical cable charts, electric test meters, wire size gauge, measuring tape, an oven, and electrical wire tables.
- Performance:
  The student will calculate, and confirm by measurement, the current carrying capacity of the wire in free air, for a one volt drop. He will determine the resistance of the wire and the effect on resistance and voltage drop of an increase in wire temperature by heating in the oven.
- Standard:
  He will read meters without error and calculate current within 20% of meter readings.

Key Points	*Feedback*
Factors in selection of aircraft cable.	•How is the correct wire gauge determined for a known electrical load? •What is the effect of length on the current carrying capacity of the wire? •Compare copper, aluminum and steel wire for aircraft electrical use. •What are the advantages of stranded wire for aircraft use? •What effect does insulation have on wire voltage and current ratings?
Temperature effects.	•What effect does a temperature increase have on current capacity of the wire? •Does a temperature increase cause a rise or a drop in voltage available at load? •What factors cause an increase in temperature in aircraft wiring?

Activities	*Check Items*
	Did the student:
Determine wire size and length.	•Remove insulation to check size of wire?
Use electrical cable charts.	•From current and voltage drop, find diameter or gauge from cable charts?
Measure resistance of entire length of wire.	•Determine current capacity for one volt drop, by ohmmeter, voltmeter and ammeter?
Measure voltage drop.	•Adjust load resistance to obtain one volt drop across wire length?
Measure current.	•Keep load resistance constant? •Assure that current does *not* exceed value shown in table?
Measure voltage drop as temperature of wire is raised.	•Use oven to increase temperature of full length of wire?
Measure resistance of wire at raised temperature.	•Use same method as before?

CALCULATE ELECTRICAL POWER.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  Ten problems concerning DC electrical power when voltage and current or resistance values are given.

- Performance:
  The student will calculate the power requirements of aircraft electrical components or devices when values of voltage and current or resistance are known. He will state correct units of measurement.

- Standard:
  Correctly answer at least seven problems.

Key Points	*Feedback*
Electrical power.	•What is the unit of measurement for electrical power? •How much electrical power is equivalent to one horsepower?
Ohm's law power formulas.	•How is the power calculated when voltage and current are known? •How is the power calculated when voltage and resistance are known? •How is the power calculated when current and resistance are known?
Power sources.	•What are the usual sources of aircraft electrical power? •What factors limit the amount of power available? •What percent of available power can be used?
Power measurement.	•What two meters are usually used to obtain the measurements needed to calculate the power used by an aircraft component? •Why is resistance seldom used as a measuring factor for calculating power requirements? •Give some examples in which power values are needed in aircraft.

Activities	*Check Items* Did the student:
Solve ten problems by calculating the power required for named components, having values of voltage and current of resistance given.	•Use ohms law correctly for solution of each problem? •Recheck his answers by using Ohm's law?
Specify the unit of measurement with each answer.	•Use correct unit of measurement to keep his answer easy to work with?

MEASURE CURRENT FLOW IN A PARALLEL ELECTRICAL CIRCUIT.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- Given:
  A DC electrical mock-up with parallel circuits to an aircraft motor, three lamps in parallel, and a solenoid relay.

- Performance:
  The student will measure the current flow to each component in the mock-up and the total current flow with all components operating.

- Standard:
  All meter readings without error and total of all individual readings within 10 percent of total current reading.

Key Points	*Feedback*
Parallel circuits.	•How is current divided between circuits in parallel? •What happens to the total current and to the current through each light, when a second light is connected in parallel with the first? •Which components cause a current surge when first turned on?
Wire size requirements.	•Compare the required size of the wire in each parallel branch circuit to the wire supplying power to the total circuit. •Will an increase to larger than required size wire cause more current flow in the connected component?

Activities	*Check Items*
	Did the student:
Connect an ammeter for measuring current in parallel circuits and the total circuit.	•Properly connect the ammeter in series with each circuit to be measured? •Show that total current from power source equals the sum of the currents in the parallel circuits?
Change load in one parallel circuit.	•Show that a change in load in one circuit does *not* effect current flow in the other circuits? •Demonstrate that use of larger than required size wire does *not* increase the current flow to a component?

DEMONSTRATE CHARACTERISTICS OF MAGNETISM.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- Given:
  Permanent magnets, iron rod, wire, iron filings, paper, battery, compass, galvanometer, fish scale and written information.

- Performance:
  The student will perform demonstrations showing lines of force around permanent and electro-magnets, around wires with current flowing in them and around wires in which current is induced by electro-magnetic induction. He will demonstrate effects of magnetic lines of force on a compass, the electro-magnetic force of attraction, and induction of current as indicated by a galvanometer.

- Standard:
  The student will perform at least ten demonstrations assigned by the instructor without error.

Key Points	*Feedback*
Theory of magnetism.	•Describe properties of a permanent magnet. •What happens in a material when it becomes magnetized? •What is residual magnetism? •Name some materials that cannot be magnetized and why?
Magnetic fields.	•What are characteristics of a magnetic field? •How can lines of force in a magnetic field be shown? •In what kind of pattern do iron filings arrange themselves in a magnetic field?
Laws of magnetic charge.	•Describe the effects of magnetic attraction and repulsion. •How is a charge given to a magnetic material? •What term is used to describe the ease with which a substance will carry lines of magnetic force?
Electro-magnetism.	•How is an electro-magnetic field created? •What is its length of duration? •What factors effect the strength of an electro-magnetic field? •What is residual magnetism? •How can it be removed?
Electromagnets.	•What makes up a practical electro-magnet? •What factors determine the strength of an electromagnet? •What is the relationship between the magnetic force of a magnet and distance it is exerted?
Solenoids.	•What is the general definition of a solenoid? •Name some uses of solenoids in aircraft.
Relays.	•What is a generally accepted definition of a relay? •If the contacts are attached to the core and move with it, what is the common name for such a relay? •Name several uses of relays in aircraft.
Induction of current in a conductor by a moving magnetic field.	•Describe the effects on a conductor when it is within a moving magnetic field. •Compare the current induced in a wire loop from a moving magnetic field in air and in an iron core. •What is the relationship between the amount of current induced and the amount of movement of the magnetic field?

Activities	*Check Items*
	Did the student:

(continued)

Perform demonstrations using iron filings on paper to show magnetic lines of force:	•Sprinkle iron filings on paper in a random fashion?
a. Around poles of a magnet.	•Tap paper to assist the filings in lining up?
b. Between unlike and like poles of magnets.	•Relate each demonstration to the principle involved?
c. Between poles of a magnet with magnetic and non-magnetic substances within the field.	•Use a variety of types of magnets to show variations in field forms?
d. Around wires with and without current flow.	
e. Around a wire which is within a moving magnetic field.	•Provide several types of moving magnetic fields?
Construct 2 coils of wire around a common center and use a battery to provide a current impulse in one coil while measuring induced opposite impulse in the second coil with a galvanometer:	•Connect the battery and galvanometer in series with the coils correctly? •Note that induced current is of opposite polarity to battery current? •Reverse polarity of the battery and obtain a corresponding reversal of induced current by the galvanometer?
a. With air as a core.	
b. With a non-magnetic metal as a core.	
c. With iron as a core.	
Demonstrate induced current action with a transformer, such as used in aircraft.	•Connect battery momentarily to primary of transformer to obtain an induced momentary current from the secondary as measured by the galvanometer?
With a compass, demonstrate polarity effects when current flow is reversed in a wire and polarity of an iron core within a coil of wire when current flow in the wire is reversed.	•Place compass adjacent to wire to obtain polarity effects? •Place compass within the field of each end of the core to show reversed polarity?
Demonstrate the magnetic force of an electromagnet using a spring scale to measure the force of attraction on an iron bar at various voltages, currents, and distances from the magnet pole piece.	•Construct a chart showing break away force plotted against applied voltage and current flow? •Chart the force required to hold the bar at various distance from the pole piece?
Demonstrate the operation of an aircraft relay.	•Show the effect of varying the distance and spring load on the moving element of the relay? •Show the effect of back spring adjustment on the moving element? •Show relation of spacing between moving element and pole piece to contact pressure and seating?
Demonstrate the operation of a solenoid.	•Check force required to remove solenoid pole piece when coil is energized?

ELECTROMAGNETIC INDUCTION.

(SEGMENT G, LEVEL 1)

Student Performance Goal

- **Given:**
  Twenty questions concerning electromagnetism.
- **Performance:**
  The student will answer questions covering the principles of electromagnetic induction, generator action, transformer action, self induction, inductance coils and magnetos.
- **Standard:**
  Correctly answer at least fourteen questions.

Key Points	*Feedback*
Definition of electromagnetic induction.	•Define electrical induction. •Relate this to electromagnetic induction. •By what two means may the electromagnetic induction be caused? •How may the magnetic field be moved?
Effect of current polarity on the electromagnetic field.	•What happens when inducing current is reversed in polarity? •What effects does insertion of an iron core have in an electromagnet?
Generator action.	•Show generator action by means of a drawing which portrays direction of flux, conductor movement and current flow. •Explain the use of the right-hand rule to determine the direction of induced voltage from generator action.
Transformer action.	•How is movement produced in the magnetic field of a transformer? •What kind of current is usually associated with transformer action?

	•Explain what is meant by primary and secondary windings. •Explain Lenz's law of voltage induced in the secondary. •What is mutual inductance? •What is the relationship of primary and secondary turns to current and voltage induced?
Self induction.	•What is self induction? •What is the name given to the force produced by self-induction? •How is self induction utilized in an induction coil to produce high voltage as for a spark plug?
Effect of a permanent magnet on an electro-magnetic field.	•What happens when a permanent magnet is inserted into an electro-magnetic field?
Magnetos.	•What type of magnet is used in an aircraft magneto? •How is self inductance utilized in a magneto? •What kind of output would a magneto develop if the breaker points failed to open?
Basic electro-magnetic induction principles of motors and generators.	•Describe the effects of rotating a coil in a fixed magnetic field. •What happens to a rotating coil when it passes through fields of alternately opposite polarity? •What happens when a permanent magnet is rotated within a coil?

11. MEASURE VOLTAGE, CURRENT, RESISTANCE, CONTINUITY, AND LEAKAGE. (EIT = 7 hrs., T = 4 hrs., L/S = 3 hrs.) 7 segments

(UNIT LEVEL 3)

MEANING OF ELECTRICAL QUANTITY PREFIXES.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
A list of twelve electrical quantitative terms using the prefixes kilo, milli, micro, meg or mega.

- Performance:
The student will write the meaning and numerical value for each of the following terms: kilovolt, kilowatt, kilohertz, milliampere, millivolt, microampere, microvolt, microfarad, megohm, megahertz, megawatt and kilovoltampere (KVA).

- Standard:
Write correct meaning and numerical value for at least ten of the terms given.

Key Points	*Feedback*
Define these prefixes: micro, meg, mega, kilo and milli.	•Which prefixes mean the quantity is less than the unit of measurement? •Which prefixes indicate more than unity? •What are the numerical values of these prefixes? •List the decimal point location for each prefix. •Work sample problems involving conversion to relative equivalent values. •Name examples of uses of these prefixes in electrical and radio frequency terminology.

USE DC ELECTRICAL INSTRUMENTS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
Appropriate text material covering basic principles of a galvanometer and DC electrical instruments.

- Performance:
The student will draw a diagram of a basic DC meter movement of the d'Arsonval type, labeling the magnet, springs, moving coil, pointer, and scale, and indicate polarity of the magnet. He will draw four simple circuits showing how a galvanometer indicates intensity and polarity of an electric current, how an ammeter is used to measure amount of current flow and how a voltmeter is used to measure voltage across a battery and across an electrical load.

- Standard:
At least five items will be correctly labeled and three of the four circuits will be correctly drawn in accordance with the given text material.

Key Points	*Feedback*
Laws of magnetism.	•Review the laws of magnetic attraction. •What is the reaction of an electro magnet in a permanent magnet field?
Basic galvanometer.	•Draw a diagram showing the basic principle of a galvanometer. •How can the galvanometer be made into a practical measuring instrument for DC?
d'Arsonval meter movement.	•Draw a simple diagram of a d'Arsonval movement. •Explain the operation of a d'Arsonval movement as used in a galvanometer.
Galvanometer uses.	•For what type of current measurement is the galvanometer most suitable? •How does the galvanometer show direction of current flow? •How does it indicate intensity of current flow?
Ammeters.	•What does an ammeter measure? •How is it connected into an electrical circuit?
Shunts. a. Purpose.	•What device can be used to permit measurement of current flow greater than the meter movement is designed to handle? •Why is a low current meter movement preferable to one built to carry greater current?
b. Internal shunts.	•Why do most ammeters contain an internal shunt? •What are some limiting factors for internal shunts?
c. External shunts.	•Draw a diagram showing how an external shunt is connected to permit measurement of large current flow. •What relative proportion of the current flow goes through the meter?
Milliammeters and microammeters.	•Compare the current measuring capacity of a milliammeter and a microammeter with an ammeter. •Why is it general practice to design DC instruments to use milliammeters or microammeters for their basic movement?
Voltmeters.	•Show by a diagram how a milliammeter may be used to measure voltage. •What changes are necessary to convert a milliammeter into a voltmeter? •How can the voltage range of a voltmeter be increased?
Connection of a voltmeter.	•How is the voltmeter connected to measure the voltage at the power source? •How is the voltmeter connected to read the voltage drop across an electrical load?

Activities	*Check Items* Did the student:
Draw a diagram showing use of a galvanometer in a circuit.	•Show the polarity of power source? •Show the correct pointer position? •Show the correct direction of pointer deflection?
Draw a diagram of a basic d'Arsonval meter movement.	•Label major components? •Show the polarity of the magnet? •Show polarity for external connections?
Draw a diagram showing an ammeter connected in an electrical circuit.	•Show polarity of power source and meter? •Show direction of current flow through the source and load?
Draw a diagram showing a milliammeter connected with an external shunt in a circuit to measure current as an ammeter.	•Show the correct connections for the shunt and the meter? •Show polarities of source, load shunt, and meter?
Draw a diagram to show how a milliammeter may be used as a voltmeter in a circuit.	•Show polarities of source, load and meter? •Show a series resistor connected between the meter and the voltage reading point?

CONNECT VOLTMETERS AND AMMETERS.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  A mock-up of a DC power source connected through appropriate switches to three aircraft electrical units, a voltmeter, an ammeter, an ammeter shunt, and test leads.

- **Performance:**
  The student will connect a voltmeter into the circuit of the mock-up to read the voltage at the source and at each unit. He will connect an ammeter into the circuit with a shunt to read the total current flow and the current flow through each separate unit.

- **Standard:**
  All connections correctly made and all readings without error within the accuracy of the instruments.

Key Points	*Feedback*
Milliammeter, the basic meter in aircraft use.	• Why is a milliammeter generally used as the basis for both voltmeter and ammeter in aircraft usage? • How does this make it possible to use one meter to read both voltage and current? • Where is the series resistor usually located? • How are voltmeters connected in a circuit? • How can a single voltmeter be used to read more than one voltage source?
Use as ammeter with a shunt resistor.	• Why is the shunt resistor usually located remote from the meter? • How is an ammeter connected to the shunt? • How can the meter be protected from excess current from a faulty shunt?
Meter ranges.	• What is meant by full scale deflection? • What criterion controls the meter range selected for a certain purpose? • What determines the maximum safe current for a voltmeter?
Meter precautions.	• What causes a below zero pointer deflection? • What precautions must be observed in connecting any DC meter?
Center-zero ammeters.	• What is the purpose of a center-zero meter? • Why are center-zero meters seldom used in aircraft?

Activities	*Check Items*
	Did the student:
Install a voltmeter in an electrical circuit.	• Connect the meter properly? • Make connections at proper points without breaking circuits?
Install an ammeter with external shunt resistor in an electrical circuit.	• Make connections so that all current to be measured flows through the shunt? • Connect the ammeter to shunt in proper polarity?
Read and record voltage and current.	• Read to nearest scale mark by interpolating? • Use proper unit of measurement?

USE A VOLTOHMMETER

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  A voltohmmeter (Simpson 260 or equivalent), various DC and AC voltage sources, a selection of typical aircraft electrical units.

- **Performance:**
  The student will perform 15 tests using a voltohmmeter. He will select suitable meter functions and ranges to measure five different DC or AC voltages, to test continuity and measure resistance of five aircraft electrical units and measure the current required to operate five DC aircraft units.

- **Standard:**
  Out of each group of five tests, the student will perform four without error.

Key Points	*Feedback*
Voltage measurement.	• How is a voltmeter connected to read voltage in any particular point of a circuit? • What are the effects on voltage readings of open and short circuits?
Voltohmmeters (VOM).	• Why is a multimeter, such as a voltohmmeter, preferred to separate meters for aircraft checking? • What is meant by mode and function selection?
Voltage mode, and DC or AC function.	• Why is it important to start with the highest voltage range if voltage is *not* known?

	•What is the lowest range that will read the voltage, the best for final reading? •Why is it necessary to know the kind of current and set the meter for it? •With the meter set for DC, what kind of reading will AC give? •With the meter set for AC, how accurately will it read DC voltage?
Ohmmeter mode, Ohms function and ranges.	•Why will a voltohmmeter serve well to test continuity? •What uses will the aircraft mechanic have for the ohmmeter functions? •Which range will most commonly be used? •Why is a battery used in the meter for this mode of operation? •Why are several ohms ranges provided?
Current mode and ranges.	•How is the current mode selected? •Which range is for highest current? •Why are most VOM's limited to DC for current measurement? •How is a test ammeter installed in a given circuit to measure current? •How does it differ from an aircraft ammeter installation? •Why should the selector first be set for the highest current range when measuring an unknown current flow? •Why are most voltohmmeters fused or protected by diodes?
High current measurement.	•Why is the highest current range (10 to 15 amperes) usually connected through separate test jacks?

Activities	*Check Items* Did the student:
Use voltohmmeter in the voltage mode. Select DC or AC voltage ranges.	•Adhere to proper precautions for meter use? •Assure that meter is set correctly for DC or AC? •Start with range for higher than the expected voltage?
Connect test leads for reading voltage.	•Observe polarity at both ends of test leads? •Make final reading on range nearest to full scale deflection?
Read and record voltage values.	•Read correct scale and voltage value?
Use voltohmmeter in the ohmmeter mode. Adjust for zero ohms.	•Read ohms on the proper scale? •Zero the pointer, while shorting the test leads, whenever an ohms range is selected? •Use proper multiplier factor when reading resistance?
Use ohmmeter for continuity testing.	•Use X1 ohms range? •Recheck zero ohms adjustment? •Make sure of the integrity of all connections while checking for continuity?
Use voltohmmeter in the current mode.	•Set selector for DC?
Select current functions and ranges.	•Select highest current function for expected maximum current?
Connect test leads for measuring current.	•Maintain adequate contact area at all connections? •Observe correct polarity? •Use separate high current jacks if necessary?
Read and record current values properly.	•Start with higher range, and read value on range nearest to full scale deflection? •Select correst scale and interpolate for accuracy? •Use proper unit of measurement?

USE OHMMETER AND/OR TEST LIGHT TO CHECK FOR OPEN OR SHORT CIRCUITS.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- Given:
A mock-up of typical aircraft electrical circuits in which the instructor has created open circuit faults at five places and short circuit faults at five places, a test light with battery and a voltohmmeter.
- Performance:
The student will use a test light and a voltohmmeter to locate open and short circuit faults and to test continuity in typical aircraft electrical circuits.

- Standard:
  Correctly locate at least two open faults and two short faults with the test light, three open faults and three short faults with the ohmmeter and determine continuity of three circuits with the test light and five with the ohmmeter.

Key Points	*Feedback*
Review open wire and single wire concepts.	• Why do most aircraft use a single wire circuit with the aircraft body as a return?
Open and short circuits.	• Is an "open" circuit always totally open? • Name some malfunctions of components which often give an open circuit indication. • Differentiate between "shorts" to ground and "shorts" between wires or connections. • Why should power usually be turned off when checking for a "short"?
Voltohmmeter for continuity testing.	• Which functions can be used for continuity testing? • Which function is preferable for aircraft continuity testing?
Review design and operation of an ohmmeter.	• Why is it necessary to have a zero setting control on an ohmmeter? • What precautions must be observed when connecting the ohmmeter into a circuit? • Which range of the ohmmeter should be used for continuity testing?
Testing for shorts.	• Why is continuity testing a good method of locating shorts?
Using a test light.	• Of what does a test light consist? • If the light comes on, does it always indicate a defective circuit?
Testing for open circuits.	• How is an open circuit located with an ohmmeter? • How is an open circuit located with a test light?
Continuity testing with a voltmeter or ammeter.	• How can voltmeters or ammeters be used to check continuity? • How reliable is a voltmeter continuity check for ground straps or battery cables? • Why is an ammeter seldom used for continuity checking?

Activities	*Check Items*
	Did the student:
Use voltohmmeter for locating open and short circuit faults.	• Familiarize himself with the circuits before testing for faults? • Make sure power was off before testing? • Use the ohmmeter function at X1 for locating shorts?
Use proper ohmmeter ranges for locating open and short circuits.	• Use higher resistance ranges to determine whether open faults are partial or total?
Use test light for locating open and short circuits.	• Check operation of test light before starting tests? • Make sure good metal to metal contact was made for each test?
Use voltohmmeter as an ohmmeter for continuity checking.	• Adhere to precautions for safe meter use?
Select function and range.	• Have the selector at R–X1?
Connect test leads for continuity check.	• Make adequate contact at check points?
Read meter scale for indications of open and short circuits.	• Set zero ohms before making check? • Read correct scale on meter?
Use test light for continuity checking.	• Select correct test points? • Check operation before using each time?

DETECT ELECTRICAL LEAKAGE.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  Aircraft cable harness, electrical connectors, and terminal strips which include ten leakage faults due to poor insulation, corrosion or moisture permeation, and a voltohmmeter or electrical leakage tester.

- Performance:
  The student will perform tests to detect electrical leakage in typical aircraft electrical cable harness, connectors and terminal strips. He will use a voltohmmeter or leakage tester to identify the type of fault causing the leakage and to determine where it is located.

- Standard:
  Correctly locate and identify seven leakage faults.

Key Points	*Feedback*
Review ohmmeter operation and uses.	• What preparation is necessary before using a voltohmmeter as an ohmmeter? • What electrical measurement is used to detect leakage?
Measurement of leakage.	• Which resistance range on an ohmmeter is best for measuring leakage? • At a high ohms range, what will be the effect of touching both connecting clips with the fingers? Why?
Leakage testers.	• What are some advantages of a specialized leakage tester compared to use of an ohmmeter? • What precautions need to be taken when using a leakage tester that has high voltage available?
Electrical leakage causes.	• What resistance should good insulation have? • How much leakage resistance may be expected if water gets into a multi-contact electrical connector? • Name some ways corrosion can be the cause of leakage.
Results of leakage.	• How may leakage effect the operation of aircraft electrical components?

Activities	*Check Items*
	Did the student:
Use a voltohmmeter or leakage tester to measure electrical leakage in cables, connectors and terminal strips. Locate and identify leakage faults as to cause or type.	• Select proper function and range? • Follow a logical procedure in making his tests? • Check resistance or leakage rate correctly? • Record location of test points for each fault indication?

MEASURE AC VOLTAGES.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- Given:

A mock-up of an AC electrical circuit having a power supply of 115 volts AC, a transformer supplying a 12 volt light, four 28 volt lights connected in series to the 115 volt supply, and a voltohmmeter (Simpson 260 or equivalent).

- Performance:

The student will measure AC voltage across the power source, the transformer secondary, and from one side of the line to each point between the sockets of the lights in series, having all lights lighted and then with one light removed.

- Standard:

Record all voltages without error within the accuracy of the instrument.

Key Points	*Feedback*
Review alternating current theory and AC voltage measurement.	• What is meant by 60 cycle and 400 cycle AC? • What is meant by R.M.S.? • Why does the AC voltmeter function of the voltohmmeter read in volts R.M.S.?
Safe selection of ranges.	• Why should a high voltage range be selected first? • Why does the lowest range that will read the voltage give the most accurate reading?
Voltage measurement.	• How can the secondary of a step down transformer be determined? • What is the expected voltage division across a series of 4 similar 28 volt lights across a power source of 115 volts AC? • What voltage division could be expected if dissimilar lights are used?
Safety precautions.	• What safety precautions should be observed when measuring 115 volts? • Should similar safety precautions be observed when measuring the 28 volt series lights?

Activities	*Check Items*
	Did the student:
Use voltohmmeter as an AC voltmeter.	• Place function switch at highest range first? • Connect test leads safely?
In an AC circuit, check voltages of 115 volts and lower.	• Read voltage on range nearest to full scale deflection? • Read and interpolate from the proper scale divisions?
Record voltage mea-measurements.	• Make a correlated record of all voltages measured?
Practice electrical safety.	• Observe safety precautions during all voltage measurement?

12. MEASURE CAPACITANCE AND INDUCTANCE.

(EIT = 4 hrs., T = 4 hrs., L/S = 0 hrs.)
2 segments
(UNIT LEVEL 1)

CAPACITANCE, INDUCTANCE AND IMPEDANCE.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Appropriate text material, and 14 questions with multiple choice answers covering capacitance, inductance and impedance.

- Performance:
  The student will select correct answers to questions concerning capacitance, and capacitive reactance, inductance and inductive reactance, and the combined effects of these two reactances in an AC circuit.

- Standard:
  Given 14 questions, select at least 10 correct answers.

Key Points	*Feedback*
Capacitance.	•What is the unit used to measure capacitance? •Explain capacitance by analogy to hydraulics. •What symbol is used in circuit diagrams to indicate capacitance?
Effects of capacitance in a DC circuit.	•Describe capacitance in a DC circuit. •What is the effect of a capacitor added across a switch which is sparking due to inductive counter emf?
Effects of capacitance in an AC circuit.	•Describe capacitance in an AC circuit. •What kinds of capacitors cannot be used in an AC circuit? •Does a capacitance aid or oppose the flow of AC?
Capacitive reactance.	•What relationship does the frequency of the AC have to the capacitive reactance? •What is the unit used to measure capacitive reactance?
Phase relationships with capacitive reactance.	•What happens to the current and voltage phase relationship as capacitive reactance is added to the AC circuit? •What happens to the power efficiency of the circuit as capacitive reactance is increased?
Dielectrics.	•What is meant by dielectric strength? •What effect does a change in dielectric strength have on capacitance? •Compare the dielectric strength of air with that of oil, gasoline, or turbine fuel.
Inductance.	•Describe the behavior of inductance in a DC circuit. •What is the unit used to measure inductance? •When current flow to an inductance is stopped, what happens? •What are the effects of inductance at the contacts of a switch controlling a solenoid relay? •What is the symbol for an inductance as used in electrical diagrams?
Effects of inductance in an AC circuit.	•Does an inductance aid or oppose the flow of AC? •What is the letter symbol for inductive reactance? •What is the unit used to measure inductive reactance? •What relationship does the frequency of the AC have to the inductive reactance?
Effects of inductive reactance.	•What happens to the current and voltage phase relationship as capacitive reactance is increased? •Why can an AC generator carry more than its rated load when it is supplying mixed inductive and capacitive load? •What happens to the power efficiency of the circuit as inductive reactance is increased?
Impedance.	•What are the three factors which comprise impedance? •What is the symbol used for impedance? •What unit is used to measure impedance? •How is impedance calculated when its three factors are known?

MEASURE CAPACITANCE IN AIRCRAFT APPLICATIONS.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- **Given:**
  A schematic diagram of an aircraft capacitor fuel quantity system, a capacity tester, examples of capacitors used in aircraft, written information.

- **Performance:**
  The student will select correct multiple choice answers to questions concerning capacitance as used for aircraft fuel quantity measurement, the principle and use of a tester for measuring the fuel quantity capacitor units and cables. He will measure the capacity of capacitors selected from examples of aircraft capacitor applications.

- **Standard:**
  Select correct answers for at least 10 of 14 multiple choice questions and list correct value and unit of measurement for at least 4 of 6 capacitors selected.

Key Points	*Feedback*
Capacitor fuel or oil quantity measuring systems.	• Explain how a capacitor will change capacity if any oil or fuel replaces air as the dielectric of the capacitor.
a. Basic design.	• What is the basic design for a capacity unit to be inserted in a fuel or oil tank in order to measure quantity of fluid in that tank?
b. Basic operation.	• What type of electricity should be applied across the capacitor unit? • How will the quantity be indicated in the cockpit? • Will the fluid be measured in gallons or pounds?
Uses of capacitors in aircraft.	• Name some uses of capacitors in aircraft ignition systems? • Why are capacitors often used across relay contacts? • What purpose does a capacitor serve when applied across the DC output of rectified AC current?
Measuring capacitance.	• What is the basic unit of measurement for capacitance? • What is the more commonly used and more practical unit of measurement for capacitors as used in aircraft applications? • What is the abbreviation for microfarad?
Capacity testers.	• What is the principle of a bridge type capacity tester? • How does a substitution type capacity tester operate? • When measuring the capacity of a capacitor, how important is the integrity of the test lead connections?
Fuel quantity capacitor testers.	• Why does a fuel quantity tester provide tests for the cables to the capacitor units as well as for the units? • Why should the fuel quantity capacitors be tested with the fuel tank both empty and full?

13. CALCULATE AND MEASURE ELECTRICAL POWER. (EIT = 2 hrs., T = 2 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 2)

DETERMINE AIRCRAFT ELECTRICAL POWER REQUIREMENTS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information and charts specifying the efficiency of an aircraft electric motor and the load at which it is to operate, and listing the various electrical units of a selected aircraft electrical system with load ratings for each unit.

- **Performance:**
  The student will calculate the electrical power required to operate the electric motor and the total power which must be furnished by the generator of the selected aircraft to supply its electrical system.

- **Standard:**
  Calculate the power requirement of each within 70% of the specifications as set forth by the aircraft manufacturer.

Key Points	*Feedback*
Determination of electric power required for a motor, given the efficiency and the load.	**•What electrical values must be known to calculate the power requirement of a motor?** **•How does efficiency of a motor effect required electrical power?** **•How does load effect the required electrical power?**
Power rating of electric motors.	**•What unit of measurement is used to rate the power of an electric motor?** **•How many watts to one horsepower?** **•What factors limit the load rating for an aircraft motor?**
Determination of total continuous load for a specified airplane.	**•What information is needed to determine the total load of an aircraft electrical system?** **•What supplies the non-continuous electrical loads when the maximum continuous load is being used?**
Calculation of the minimum generator output which will meet specifications.	**•Why is it specified that maximum load shall not exceed a certain percent of generator rating?** **•Why does this apply only to the continuous total load of the airplane electrical system?** **•What factors limit the maximum capacity of the generator on an aircraft?**
Measurement of power.	**•Why is it impractical to measure power by a direct instrument in an aircraft DC electrical system?** **•What two measurements are needed to measure DC power by calculation?** **•What type of instrument can be used to measure AC electrical power?** **•Why is there little need for any direct power measuring meters in aircraft electrical systems?**

Activities	*Check Items* **Did the student:**
Calculate the electrical power required to operate an electric motor.	**•Take into consideration the efficiency of the motor?**
Calculate the total electrical power which must be furnished by a generator to supply the electrical units of a selected aircraft.	**•Obtain the power requirements for each electrical unit of the selected aircraft from the manufacturer's manual?** **•Take into consideration the specified percent of generator rating which the maximum load must *not* exceed?**

14. READ AND INTERPRET ELECTRICAL CIRCUIT DIAGRAMS. **(EIT = 6 hrs., T = 3 hrs., L/S = 3 hrs.) 4 segments**

(UNIT LEVEL 3)

IDENTIFY COMMONLY USED AIRCRAFT ELECTRICAL AND ELECTRONIC SYMBOLS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  Examples of aircraft wiring diagrams and schematics which include, without labels, all commonly used electrical and electronic symbols presently used in aircraft electrical system diagrams.

- **Performance:**
  The student will locate and label the symbols for the following electrical units: batteries, generators, motors, fuses, circuit breakers, switches, solenoids, relays, pressure switches, capacitors, single-phase and three-phase transformers, single and bridge rectifiers, SCR's, solid state amplifiers and gates, lights, ammeters, voltmeters, resistors, rheostats, potentiometers, bells, horns, terminal strips, plugs and receptacles.

- **Standard:**
  Of twenty-eight different symbols, locate and label correctly at least twenty-two.

Key Points	*Feedback*
Aircraft electrical symbols.	**•Why use symbols instead of pictures of units?** **•How much information can a symbol of a motor give?** **•Why has it become necessary to standardize electrical and electronic symbols used in aircraft diagrams?**
Designation of specific applications for symbols having more than one use.	**•How does the symbol for a motor or generator show which unit it designates?**

	•How is the symbol for an indicator or meter differentiated from the same symbol as used for a motor or generator? •How can the symbol for a resistor be modified to indicate it is variable?
Indications of position or direction.	•In what position with reference to power is the symbol for a switch or relay normally shown? •How are normally open contacts differentiated from normally closed contacts? •In the symbol for an amplifier, how is the signal direction indicated?
Indications of type of operation.	•In the symbol for a circuit breaker, how is the type or method of operation shown? •How do symbols for connectors differentiate between plugs and receptacles, pins and sockets? •How does an indicator light symbol show whether or not it can be pushed to test?

Activities	*Check Items*
	Did the student:
On unlabeled electrical wiring diagrams or schematics, locate and label the symbols for at least twenty-nine different electrical and electronic items.	•Correctly identify similar items shown for different applications? •Correctly identify items with the same symbol, but different letters, such as a generator and motor?

TRACE CIRCUITS WITH AIRCRAFT WIRING DIAGRAMS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Aircraft electrical wiring diagrams for a variable brightness light, a relay controlled motor and an outside temperature sensor and indicator; mock-ups containing all units shown in the selected diagrams; wire, hardware, and power sources to properly connect each circuit shown.

- Performance:
  The student will trace each circuit and connect the units as shown in each wiring diagram to provide the following operating systems: a variable brightness cockpit light, a remotely controlled electrical motor, and an aircraft outside temperature indicating system. He will attach labels to each wire to correspond with the numbers in the diagram.

- Standard:
  All wiring will correspond to the wiring diagrams so that each system will operate as designated and without electrical hazard.

Key Points	*Feedback*
Types of circuit diagrams. a. Simplified schematics.	•What information is desired to be shown by a simplified schematic of a circuit? •Why is a simplified schematic usually easier to use in troubleshooting than a full wiring diagram?
b. Block diagrams.	•What information is intended to be shown by a block diagram? •Why are block diagrams generally used for more complex circuits?
c. Wiring diagrams.	•Why should a wiring diagram show all possible details of the circuit and system? •Where does a wiring diagram usually start and on which side of the diagram is this usually located? •Why is electrical power usually shown as "off"?
Tracing electrical circuits.	•What is the best starting point when tracing an electrical circuit? •What methods can be used to convert a circuit diagram to show power "on" and components operating? •How can any specific wire be identified in most aircraft installations? •What assistance can a volt-ohmmeter provide in tracing electrical circuits in an aircraft?

Wire numbering systems.	•Why is it necessary to number each wire at several points? •What information is usually coded into the wire number? •How are consecutive sections of a wire run indicated?

Activities	*Check Items*
	Did the student:
Identify electrical symbols in aircraft diagrams and interpret their functions.	•Properly interpret the electrical condition of each circuit? •Properly identify each unit by its symbol? •Properly interpret the function of each controlling unit?
Trace electrical circuits in aircraft circuit diagrams.	•Properly identify the wire designation and contact coding? •Follow the electrical flow path correctly? •Observe polarity indications?
Connect units on mock-ups.	•Connect each circuit in proper sequence? •Make sure no power was applied while connecting any circuit? •Provide adequate contact surface and proper insulation for all connections?
Check operation of completed circuits.	•Check each circuit against its wiring diagram for accuracy and completeness before applying power? •Test each circuit for proper operation with power applied? •Use proper electrical safety practices during all stages of his work?
Type or print wire numbers on tape. Attach tapes to appropriate wires.	•Use same code numbers and letters as in wiring diagram? •Make several labels for each wire run and attach in strategic places?

ELECTRONIC SYMBOLS AND SCHEMATICS IN AIRCRAFT USE.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- Given:
  Aircraft electrical schematics which include unlabeled schematic symbols for electronic solid state switching and controlling devices; written information concerning such symbols and devices.

- Performance:
  The student will identify and label twenty schematic symbols for solid state devices including: transistors, diodes, logic gates, amplifiers, and sensor or proximity switches.

- Standard:
  Correctly label at least fourteen symbols.

Key Points	*Feedback*
Symbols for diodes and transistors.	•What indicates the direction of forward current flow in these symbols? •What is the relative amount of reverse flow? •How is the polarity for this current flow usually determined?
Purposes and functions of diodes and transistors in aircraft electrical systems.	•Why are diodes and transistors used in place of switches and relays? •How fast do they operate? •How dependable are they?
Symbols for logic gates and electronic amplifiers in aircraft control circuits.	•What components may be replaced by logic gates and electronic amplifiers? •How is the direction of operation indicated in amplifier symbols?
Symbols for sensor or proximity switches.	•What is the principle of operation for a sensor or proximity switch? •How does its symbol indicate whether the sensing arm is at the sensor or away?

IDENTIFY ELECTRICAL MALFUNCTIONS BY REFERENCE TO CIRCUIT DIAGRAMS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  Five typical reports of malfunctions in aircraft electrical systems, and circuit diagrams of the systems involved.

- Performance:
  The student will identify the failed components or circuit faults which could be the cause of each malfunction, by reference to the circuit diagrams for each of the systems involved.

- Standard:
  Identify correctly at least one component or circuit fault which could be the cause of each reported malfunction.

Key Points	*Feedback*
Analyze malfunction report by reference to circuit diagram which applies.	•Why is an analysis of the applicable circuit a desirable starting point in troubleshooting electrical malfunctions? •Why is it helpful to list all items or devices related to the malfunction?
Considerations when using circuit diagrams for electrical troubleshooting.	•Why is it important that the person tracing a circuit have a basic understanding of the system involved? •What is the value of using a process of elimination when attempting to identify malfunctions by reference to circuit diagrams? •What is the value of considering the effects of a failed unit on the other components of the system? •Should the easiest unit replacement always be given priority?

Activities	*Check Items*
	Did the student:
Use circuit diagrams to assist in troubleshooting.	•Correctly read circuit diagrams and interpret unit operation? •Accurately pinpoint possible causes of system malfunction? •List possible causes and establish priority of replacement by logical reasoning?

15. INSPECT AND SERVICE BATTERIES. (EIT = 10 hrs., T = 5½ hrs., L/S = 4½ hrs.) 4 segments (UNIT LEVEL 3)

PRINCIPLES OF BATTERY CONSTRUCTION AND OPERATION.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
Written information, charts or diagrams and unlabeled cutaway drawings of lead-acid and nickel-cadmium aircraft storage batteries.

- **Performance:**
Answer twenty questions concerning the principles of construction of lead-acid and nickel-cadmium batteries, the chemical actions that take place during charge and discharge, the factors that effect voltage, current and ampere-hour capacity, and label the components of each type of battery in cutaway drawings.

- **Standard:**
Correctly answer at least 14 questions and properly label at least 6 components of a possible 9 in each of the two cutaway drawings.

Key Points	*Feedback*
Primary and secondary cells.	•Which type of cell is used in a flashlight? •Where does the energy in a primary cell come from? •Describe how a secondary cell functions.
Aircraft storage battery types.	•What are the two types of storage batteries most commonly used in aircraft? •Describe the construction of a lead-acid battery.
a. Lead-acid batteries.	•What are the active materials of the lead-acid cell? •What electrolyte is used? •Describe the chemical action in a lead-acid cell. •What material is formed on the plates during discharge?
b. Nickel-cadmium battery.	•Describe the construction of a nickel-cadmium battery. •What are the active materials? •What electrolyte is used? •Describe the chemical action of a nickel-cadmium cell. •What happens to the electrolyte level during charge and discharge?
Voltages of individual cells.	•What are the nominal voltages of lead-acid and nickel-cadmium single cells? •What is the safe range of voltages during charging of each type of battery?
Battery capacity and rating.	•What are the design factors that effect battery capacity? •What is meant by ampere-hours?

	•Compare capacity and maximum available current for lead-acid and nickel-cadmium batteries. •What are some causes of loss of capacity in each type of battery?

Activities	*Check Items* Did the student:
In cut-away drawings of lead-acid and nickle-cadmium aircraft storage batteries, label each component of each type of battery.	•Identify all important components? •Indicate polarity for each type of plate group?

CHARACTERISTICS OF AIRCRAFT STORAGE BATTERIES.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- Given:
  Multiple choice questions concerning aircraft storage battery characteristics, and written text material.

- Performance:
  The student will select correct answers for 20 questions concerning aircraft storage battery characteristics including effects of series and parallel connections of cells and batteries, cell internal resistance effects, charging rate effects, constant voltage and current charging methods, safety precautions in battery servicing, temperature effects, specific gravity of electrolyte, and comparative advantages of lead-acid and nickel-cadmium batteries.

- Standard:
  Select correct answers for at least 14 questions.

Key Points	*Feedback*
Series and parallel connection of cells or batteries.	•What are the effects on voltage and current when cells or batteries are connected in series, parallel and series parallel? •How are the cells connected in most aircraft storage batteries?
Shorted cells in lead-acid batteries.	•Why will an excessive rate of discharge result in internal shorting of cells? •What provision is made in aircraft batteries to avoid internal shorting of cells from sediment prior to normal cell wear out?
Internal resistance.	•What is the effect of the internal resistance on the output voltage of a battery under load? •How does an increase in internal resistance of a cell effect the charging requirements for the battery?
Battery charging. a. Constant voltage method.	•What is the effect on the charging current when the charging voltage is kept constant? •Why are nickel-cadmium batteries generally charged by the constant voltage method?
b. Constant current method.	•What happens to the voltage when constant current charging is being conducted? •Why is this method generally used for charging several lead-acid batteries? •For multiple battery charging, how are the batteries connected for each method of charging? •Which method of charging is normally used for batteries while installed in aircraft?
c. Charging rates.	•Why should the maximum charging rate specified by the manufacturer never be exceeded? •What will be the effects of an excessive charging voltage?
d. Precautions.	•What safety precautions must be observed when connecting the disconnecting batteries during charging? •Why should lead-acid batteries or service equipment never be used around nickel-cadmium batteries? •What are the hazards in handling electrolyte?
Temperature effects.	•How does temperature effect battery charging rates? •How does temperature effect hydrometer readings?
Specific gravity of electrolyte.	•What are the specific gravity ranges for each type of battery? •Can this be checked in each type?

	How does state of charge effect each? Compare the safe charging rates for lead-acid and nickel-cadmium batteries. What liquid is used to replenish cells in each type of battery?
Precautions.	Compare the required purity of water for lead-acid and nickel-cadmium cells. Why should lead-acid and nickel-cadium batteries be kept completely apart for storage, handling and charging? What safety precautions should be observed when handling any batteries or electrolyte?
Cold weather problems.	Under what conditions of charge in lead-acid batteries will electrolyte freeze most readily? What is the freezing danger for nickel-cadium batteries?
Comparative advantages and disadvantages of lead-acid and nickel-cadmium batteries.	Compare the ampere-hour capacities and maximum discharge rates of lead-acid and nickel-cadmium batteries. Compare the two types of batteries as to danger of freezing and from excessively high temperatures. Compare their relative weight and size. What are the hazards from corrosion relative to each type of storage battery?

INSPECT AND RECHARGE AIRCRAFT STORAGE BATTERIES.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
  Aircraft storage batteries of lead-acid and nickel-cadmium type, appropriate battery charging equipment, hydrometer, high rate discharge tester, voltmeter and written information conforming to manufacturer's specifications.
- **Performance:**
  The student will perform the following battery service procedures for both lead-acid and nickel-cadmium batteries: case inspection, check state of charge, check electrolyte level and replenish to specified level, prepare and connect batteries for recharging. He will also perform a high rate discharge test for a lead-acid battery and describe how to prepare a dry-charged lead-acid battery for service.
- **Standard:**
  Perform all procedures without error in accordance with the written information provided.

Key Points	*Feedback*
Lead-acid battery service.	How frequently should the battery be serviced? What flaws should be looked for during case inspection? Describe the method of checking electrolyte level and replenishing. What temperature correction must be made for a hydrometer reading of a specified gravity? Give the hydrometer reading for a cell at full charged, half-charged, and discharged condition at 50°F temperature.
Charging procedures.	Why is it important to monitor batteries while being charged? Describe the method of connecting and controlling constant current chargers? What is the effect on batteries of excessive charging rates? How are multiple batteries connected for constant voltage charging? What limits the current to a discharged battery in constant voltage charging?
High rate discharge test.	Can all aircraft batteries be given the high rate discharge test? Why must the battery be fully charged before this test will be valid? When is a high rate discharge test desirable? Explain how to correctly perform the high rate discharge test.

Trouble symptoms.	•What does an excessive difference in specific gravity between cells indicate? •What causes a cell to lose its state of charge? •How does the rate of charge provide an indication of an increase in internal resistance in one or more cells?
Nickel-cadmium battery service.	•Why should no lead-acid service equipment be used to service nickel-cadmium batteries?
a. Case inspection.	•Why does the nickel-cadmium battery case require adequate ventilation? •Why is cleanliness stressed in nickel-cadmium battery installations? •Why is it important to maintain high resistance between case and ground? •Describe the method of checking the cap vents. •When and how is the electrolyte level checked in a nickel-cadmium battery? •What happens to the electrolyte level during charge and discharge? •What precautions must be taken in replenishing nickel-cadmium batteries?
Checking state of charge.	•Explain the method of determining state of charge for a nickel-cadmium battery. •Explain how to equalize a battery if the cell voltages vary. •How is negative pressure obtained for an overboard drain hose? •When a sump jar is used, what is kept in it?
Preparation of dry-charged battery for installation.	•Why is it common practice to ship batteries dry-charged? •What precautions are to be taken when the electrolyte is being added to the dry-charged battery? •Does the battery need charging after the electrolyte has been added?

Activities	*Check Items*
	Did the student:
Perform external inspection of battery cases and vent caps for lead-acid and nickel-cadmium batteries.	•Inspect the battery for: a. Terminal security? b. Cracks? c. Cleanliness? d. Integrity of cap vents?
Check electrolyte level and adjust as needed.	•Use proper method and time for adjusting electrolyte level?
Test electrolyte specific gravity.	•Use hydrometer? •Correct for temperature?
Charge batteries: a. Constant current method. b. Constant voltage method.	•Have leads properly connected for method being used? •Avoid excessive charging rate? •Loosen vent caps? •Have power "off" when being connected and disconnected?
Perform high rate discharge test on lead-acid battery.	•Have battery fully charged before test started? •Have caps removed? •Observe safety precautions?
Check cell and terminal voltage.	•Use voltmeter? •Avoid contamination from previous use with lead-acid batteries?

PERFORM REMOVAL, INSTALLATION AND COMPARTMENT MAINTENANCE FOR AIRCRAFT BATTERIES.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  A battery compartment of an aircraft or a mock-up of same, with an aircraft battery installed, and related written information and procedures.
- Performance:
  The student will remove the aircraft battery and spilled electrolyte, treat adjacent areas, inspect and clean terminal connectors and reinstall the battery.
- Standard:
  All work will be accomplished in accordance with the written procedures and to return-to-flight standard.

Key Points	*Feedback*
Battery removal procedures.	• **What safety precautions must be observed before and during battery removal?**
Battery compartment inspection.	• **Describe the requirements for battery compartment inspection.** • **What is the correct method of removal and treating for spilled electrolyte from lead-acid and nickel-cadmium batteries?** • **Are there any different procedures for electrolyte spilled outside the battery compartment?** • **How is ventilation provided for the compartment and the battery in non-pressurized and pressurized airplanes?** • **What happens if the terminal connectors become corroded?**
Battery installation procedures.	• **What are the hazards if a battery is installed with airplane power turned on?** • **What damage may result from a battery installed backwards?**
Substitution of a nickel-cadmium battery for a lead-acid type.	• **What is the required capacity for a nickel-cadmium battery to be substituted for a 100 ampere-hour lead-acid battery?** • **What service precautions must be taken before a nickel-cadmium battery may be substituted for a lead-acid type?**

Activities	*Check Items*
	Did the student:
Remove battery.	• **Turn the power off?** • **Disconnect the battery leads properly?** • **Handle the battery with proper caution?**
Inspect and clean battery compartment.	• **Use proper neutralizer?** • **Observe precautions against fumes?**
Reinstall battery.	• **Connect the battery in correct polarity?** • **Make connections with adequate contact area?** • **Install hold down clamps and tie them down safely?**

16. OVERHAUL AIRCRAFT ELECTRICAL COMPONENTS. (EIT = 23 hrs., T = 12½ hrs., L/S = 10½ hrs.) 7 segments

(UNIT LEVEL 2)

BASIC OPERATING PRINCIPLES AND INTERNAL CIRCUITS OF AIRCRAFT DC GENERATORS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information, schematic diagrams, and questions with multiple choice answers.

- **Performance:**
  The student will select answers for 20 questions dealing with basic principles of operation and internal electrical circuits for series, shunt and compound wound aircraft DC generators.

- **Standard:**
  Select at least 14 correct answers.

Key Points	*Feedback*
Review of basic DC generator principles.	• **Where is the magnetic force developed?** • **If an open occurs in the field circuit, what happens to the magnetic force?** • **Where is the output current induced?** • **Will the induced current in the armature be AC or DC as it is delivered to the commutator?**
Commutator and brushes.	• **What is the purpose of the commutator and brushes?** • **How is commutator ripple filtered by a capacitor?** • **What is the relationship of the comutator segments to the armature windings?** • **How vital is it that brushes be positioned exactly 180 degrees apart for a two pole generator?**
Neutral plane for brushes.	• **What is the neutral point for the brushes?** • **What is the effect of brushes not properly aligned to the neutral plane?**
Series wound generators.	• **Why is it necessary to use heavy wire in the field of a series wound generator?**

	• What is the relationship of output to load in a series generator? • What could happen if a heavy load is suddenly turned on? • To what extent are series generators used in aircraft?
Shunt wound generators.	• What are the relationships of output current and voltage to rotational speed and load variations in shunt wound generators? • How can a shunt wound generator be regulated to maintain constant output voltage under the variable RPM and load of aircraft use?
Compound wound generators.	• Why does a compound generator have less output variation with load than a shunt generator? • Why are the series field windings called compensatory or equalizing windings? • Why does a compound generator of same output rating generally weigh more than a shunt generator? • Why are compound DC generators more suitable for multiple aircraft generator installations than shunt generators?
Interpoles (commutating poles).	• What are interpoles and where are they located? • What effect will interpoles have on the neutral plane for the brushes? • How do interpoles reduce armature reaction in a DC generator?

LOCATE AND USE OVERHAUL INFORMATION FOR AIRCRAFT GENERATOR REPAIR.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:

Manufacturer's overhaul and repair manual or equivalent publication, an aircraft generator, appropriate tools, equipment and parts.

- Performance:

The student will locate procedures for overhauling the aircraft generator. He will use the procedures in the manual as a guide in disassembling, overhauling and reassembling the generator and replacing or repairing worn or defective parts as needed.

- Standard:

All steps will be performed in accordance with the overhaul manual procedures.

Key Points	*Feedback*
Aircraft manuals.	• Describe commonly used methods of indexing in aircraft manuals. • What is the difference between an overhaul manual and a service or maintenance manual? • What is the basic difference between repair and overhaul? • Why is it advisable to read the step-by-step procedures before starting the disassembly? • Why is it important that the procedures be followed and specified tools or equipment be used?
Disassembly and inspection of parts.	• What care should be taken for cleanliness and orderliness during disassembly? • What is meant by the word inspect when applied to component disassembly? • Why should all parts be inspected as they are disassembled?
Determining need for repair or replacement of worn parts.	• Where can specifications be found as a guide in determining when a worn part must be replaced? • During overhaul of a component, why is replacement of defective parts usually preferred over repair? • Where can the nomenclature and parts numbers for needed replacement parts be obtained? • Why are seals usually replaced regardless of condition?
Reassembly of components.	• Why is it important that reassembly be done in the exact sequence specified by the service manual?

	•Why is it important that torque values for bolts or nuts be complied with when specified? •Explain how a specified torque value may be obtained when a calibrated torque wrench is not available. •What is the reason for the use of lock washers or locking nuts?
Check each component for acceptable operation.	•Explain what constitutes a good safety. •Where are the procedures for checking operation usually found?
Recording of repairs.	•Why is it important that some form of record be kept of all repairs accomplished, with sign off by the mechanic or mechanics who did the job? •What is the significance of a yellow tag when used with overhauled or repaired components? •Why should the airplane and/or engine number be recorded on the yellow tag?

Activities	*Check Items* Did the student:
Locate overhaul and repair information in the manufacturer's manual for an aircraft generator.	•Follow procedures step-by-step?
Disassemble the generator.	•Identify all parts and tools from diagrams or drawings?
Inspect all parts as disassembled.	•Tag or mark any defective parts?
Clean and store parts in an orderly fashion.	•Arrange parts in order of removal?
Repair or replace worn or defective parts as time or availability permits.	•Use proper nomenclature and parts number for obtaining parts to be replaced? •Replace any damaged bolts, nuts, washers or seals?
Reassemble all parts.	
Torque and safety bolts or nuts as specified.	•Make sure all lock washers, lock nuts and safeties are installed as called for?
Complete a report showing repairs accomplished and with proper sign off.	•Record repair performed, date completed and sign off by student or students performing the repair or overhaul?

INSPECT AND OVERHAUL AIRCRAFT DC GENERATOR AND MOTOR.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
Manufacturer's manuals or equivalent written information, an aircraft DC generator, an aircraft DC motor, suitable tools, service equipment and parts.

- **Performance:**
The student will disassemble the generator and the motor, inspect the armature, use an ohmmeter or test light to check for shorts or opens in the field circuits, dress or turn the commutator surfaces, install and seat new or replacement brushes, reassemble the generator and motor, and flash the field of the generator.

- **Standard:**
Work will be performed in accordance with procedures provided and will be accomplished to return-to-service standards.

Key Points	*Feedback*
Inspection and testing of armatures.	•What is the indication of an armature winding that is shorted to ground when using a "growler" to inspect the armature? •What are probable indications of a short between turns of an armature winding? •How can an ohmmeter or test light be used to test for shorts and opens in the armature windings?
Checking field circuits.	•At what points in the field circuits should an ohmmeter or test light be connected for short and open circuit checks? •What further checks can be made to help determine the condition of the field circuit of the generator?
Need for correcting worn and rough commutator surfaces.	•What symptoms will indicate brush arcing? •How can the need for turning or dressing down a commutator be determined? •What are the harmful effects of a rough or pitted commutator?
Bearing and housing inspection.	•How are bearings checked for wear? •What causes premature bearing failure?

	•How are bearings replaced? •How are bearing housing tolerances checked? •What precautions should be observed while working with bearings?
Dressing or smoothing a commutator.	•What type of abrasives are permitted for smoothing a commutator? •What will be the effect of a commutator out-of-round? •Why is a minimum diameter specified? •Why is it necessary to undercut a commutator that has been turned down?
Brushes and brush assembly inspection and repair.	•Where is the minimum brush length specified? •How are the correct replacement brushes determined? •Where are the instructions for replacing brushes to be found?
Seating of brushes.	•Why is emery cloth forbidden for dressing commutators or seating brushes? •Why is a minimum contact area specified?
Brush spring tension and alignment.	•How is brush spring tension measured? •What effect will incorrect spring tension have on generator operation? •What is the effect of brushes not in the neutral plane?
Flashing the field of a generator.	•What type of battery may be used to flash the field of a generator? •How important is the observance of correct polarity when flashing the field? •How long should the battery be connected to the field?

Activities	*Check Items*
	Did the student:
Disassemble a DC generator and a DC motor.	•Properly place armatures on "growler"?
Inspect the armatures of the generator and the motor with a "growler."	•Check for transformer action by use of a steel blade?
Check armatures for shorts and opens.	•Properly use ohmmeter and/or test light?
Turn down, dress and undercut commutators.	•Properly use lathe and tools? •Correctly measure diameter?
Install new or replacement brushes and seat them.	•Correctly select replacement brushes? •Adhere to procedures and specifications for seating brushes?
Reassemble the generator and the motor.	•Follow procedures step by step?
Flash the field of the generator with a flashlight battery.	•Connect battery in correct polarity?

METHODS USED TO PROTECT ARMATURE SHAFTS FROM OVERLOAD.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- Given:
  Written information, sample quill shafts, shock drives, and belt drives for aircraft generators or alternators.

- Performance:
  The student will identify five samples of aircraft generator or alternator drives. He will write a description, for each type of drive, of the method provided with that drive to protect the armature or rotor shaft against damage by overload.

- Standard:
  Four samples will be correctly identified and four written descriptions will be in accordance with the information provided.

Key Points	*Feedback*
Generator armature overload protection by a quill shaft.	•How does the quill shaft couple the armature shaft to the engine accessory drive pad? •What is provided to assure that the quill shaft will shear before the armature is damaged when an overload occurs? •How is a quill shaft replaced?
Protection by rubber shock drive.	•How is the armature protected against minor overloads by the rubber shock drive? •When a severe overload occurs, how does the shock drive provide protection to the armature? •Describe the repair procedure for a rubber shock drive which has been damaged by an excessive overload of the generator armature.

Protection provided by a belt drive.	• How does a belt drive provide protection against overload of the armature? • What are the common troubles encountered in the use of belt drives? • Describe the procedure for replacing a drive belt.

DESIGN FACTORS AND CONTROL METHODS FOR AIRCRAFT AC GENERATORS.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- **Given:**
Written information, questions with multiple choice answers concerning frequency and voltage control for aircraft AC generators.

- **Performance:**
The student will select answers for fourteen questions concerning aircraft AC generators, how output frequency is controlled, how output voltage is controlled and regulated, how frequency and voltage can be manually adjusted from the cockpit, and what methods are provided to disengage the generator in an emergency.

- **Standard:**
Select correct answers for at least ten questions.

Key Points	*Feedback*
Factors that determine frequency of AC generator output.	• Does the number of windings in the field relate to the voltage or the frequency of the output? • What is the relationship of number of magnet poles to frequency of the output? • Given a specific number of windings and magnet poles, what determines the frequency of the output? • What effect on frequency will an increase in rotation speed have?
Brushless generators.	• How does operation of the brushless generator differ from brush-type generators? • What are the advantages and disadvantages of brushless generators?
Factors that determine output voltage.	• What effect does the number of turns in the field windings have on the output voltage? • With no change in field excitation, what effect will change in rotation speed have on output voltage?
Regulation of frequency by controlling rotation speed.	• How does a constant speed drive provide accurate frequency control for an AC generator? • How can the rotational speed of the CSD governor be regulated? • If an AC generator produces four cycles per revolution, at what RPM must it operate to develop 400 cycle AC? • Where no manual correction is provided in the cockpit, how can the CSD governor be adjusted to increase or decrease controlled RPM of the generator?
Regulation of voltage.	• With an AC generator operating at constant speed, what factor can cause the output voltage to vary? • How will the field excitation current relate to the output voltage? • How can minor corrections in voltage be accomplished?
Supplying a DC aircraft electrical system from an AC generator.	• In an AC generator, supplying DC through a system of rectifiers, of what concern is the AC output frequency? • Where are the rectifiers normally located? • Why is a three phase AC generator preferable to a single phase type for aircraft use?
Emergency disconnect.	• What provision is made to disengage the generator from the CSD in an emergency? • How can the generator be re-engaged?

CHARACTERISTICS AND OPERATING PRINCIPLES OF AIRCRAFT ELECTRIC MOTORS.

(SEGMENT F, LEVEL 1)

Student Performance Goal

- **Given:**
Written information and multiple completion essay statements concerning characteristics and operating principles of aircraft electric motors.

- **Performance:**

The student will complete essay statements, by filling in the blanks, which deal with the speed and load characteristics of series, shunt, and compound wound electric motors, the function of a commutator and brushes in an electric motor, the operating principles of magnetic clutches and brakes in aircraft electric motors, and the data that is needed for determining a suitable replacement motor.

- **Standard:**

Complete at least seven essay statements correctly.

Key Points	*Feedback*
Speed and load characteristics of DC electric motors of series, shunt, and compound wound types.	•What effect does an increase in load have on the speed and torque of a series wound motor? •What is the starting torque characteristic of a series wound motor where the load is heavy when first started? •Why is a shunt wound motor called a "constant speed" motor? •What is the relative starting torque of a shunt wound motor? •Describe the speed and torque characteristics of a compound wound motor. •Why is a compound motor best for an operation subject to sudden heavy loads?
Aircraft uses for DC motors.	•Name examples of aircraft applications for each type of DC motor (series, shunt, and compound). •Why are high speed and relatively high current motors usually selected for aircraft applications?
Functions of the commutator and brushes in an electric motor.	•Compare the function and operation of the commutator and brushes in a motor and generator. •If emery cloth is used on the commutator of a motor, what malfunctions may it cause?
Magnetic clutches and brakes.	•What is the primary function of a magnetic clutch and brake mechanism in an aircraft motor? •Why is a clutch needed between the armature and the brake when the brake must stop the mechanical action instantly? •Name aircraft motor applications where an instant stop is necessary.
Data needed for determining a suitable replacement motor.	•Where can the data, such as speed, horsepower, current, and voltage usually be found for an aircraft motor? •What other data is usually needed in selecting a replacement motor? •Why is it usually not practical to interchange AC and DC motors?

CHECK OPERATION OF A REVERSIBLE MOTOR AND ADJUST LIMIT SWITCHES.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- **Given:**

Written information, an unlabeled schematic diagram and a mock-up of an aircraft cooling door or other device actuated by a DC reversible motor, with written procedures or check sheet for adjustment of limit switches.

- **Performance:**

The student will label the diagram to identify the motor armature, opening and closing field windings and limit switches, control relays, control switch and power supply circuit components. He will check the operation of the motor, and adjust the limit switches for proper actuator travel.

- **Standard:**

At least eight correctly labeled diagram components, operational check and travel adjustment performed in accordance with written procedures or check sheet provided.

Key Points	*Feedback*
Aircraft reversible electric motors.	•How many windings does the field of an aircraft reversible motor usually have and what is such a field called? •How is the direction of rotation usually selected? •Why is an aircraft reversible motor usually series wound? •How many brushes does an aircraft reversible motor have?

	• At what angle to the commutator are the brushes mounted?
Drive mechanism and limit switches.	• What mechanism is provided to make it possible for a small high speed reversible motor to safely drive large mechanical loads such as landing gear or wing flaps? • Why are limit switches needed? • Where are the limit switches usually located? • What is the name given to the assembly containing the reversible motor and its drive mechanism? • Why are relays or solid state gates often used between the control switch and field windings?
Limit switch adjustment.	• What is the reason a method of adjustment is usually provided for both limit switches? • Why is it very important that adjustment procedures given in the service instructions be strictly adhered to? • Describe how indicator lights may be operated by the limit switches to give cockpit indication of operation in either direction of travel.

Activities	*Check Items*
	Did the student:
Label the components in an unlabeled circuit diagram of an aircraft cooling door or other device actuated by a reversible DC motor.	• Use correct terminology for his labels? • Show direction of travel for each field winding and limit switch?
On a mock-up of an aircraft cooling door or other device actuated by a reversible motor, check operation of the motor and adjust the limit switches for specified travel of the actuated device in each direction.	• Use the check sheet or procedures provided? • Make adjustments in the proper order? • Check operation through full travel in each direction?

17. FABRICATE AND INSTALL RIGID AND FLEXIBLE FLUID LINES AND FITTINGS. (EIT = 25 hrs., T = 8½ hrs., L/S = 16½ hrs.) 6 segments

(UNIT LEVEL 3)

BEND ALUMINUM AND STAINLESS STEEL TUBING.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Written information, samples of aluminum and stainless steel tubing of various diameters, tube bending tools and equipment.

- Performance:
  The student will make three bends in soft aluminum tubing using hand bending methods. He will make 3 bends each in aluminum alloy and stainless steel tubing using hand or production bending tools.

- Standard:
  All bends will meet return-to-service standards for circular shape and smooth appearance and will conform to minimum bend radii rules.

Key Points	*Feedback*
Minimum bend radii.	•Why is a minimum radius established for a tube bend? •How is the radius of a tube bend measured? •Which method would help obtain a satisfactory bend to an aluminum tube under field or emergency conditions? •What is a good rule of thumb for determining minimum bend radius for hand bending of soft aluminum? •Compare the minimum bend radii for aluminum alloy and stainless steel tubing of the same outside diameter, for certificated aircraft tubing installations.
Soft aluminum tubing bent by hand.	•How is a filler such as dry sand used in hand bending? •What are "spring type benders" and how are they used in hand bending? •What is the largest OD soft aluminum tubing (1100, 3003, or 5052) which may be bent by hand?
Hand tube bending tools.	•Why does a hand bending tool require separate attachments for each OD size of tubing? •How can the desired angle of bend be obtained with a hand bending tool? •What is provided to assure proper roundness of the tube in the bend?
b. Power tube bending.	•How does a production tube bender differ from a hand bending tool? •How is the production bender adjusted for the OD of the tubing? •How is a mandrel used for bending thin wall tubing and for bends of less than standard radius?

Activities	*Check Items* Did the student:
Select samples of soft aluminum tubing of suitable OD and make 3 hand bends of various angles as assigned by the instructor.	•Determine maximum OD which may be bent by hand? •Follow proper method of using filler in tubing?
Make 3 bends in aluminum alloy tubing and 3 bends in stainless steel tubing using hand bending tool or production bending machine.	•Measure and mark tubing for acceptable minimum bend radii for all bends? •Select proper attachments for hand bending tool or properly adjust the production bending machine?

FORM A BEAD ON TUBING.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Aluminum tubing, beading tools and reference information pertaining to the beading of tubing.

- Performance:
  The student will form a bead at the tubing ends of two different diameters of aluminum tubing.

- Standard:
  The beads formed on the tubing will comply with MIL Specifications and comply with the dimensions and quality of workmanship established by these specifications.

Key Points	*Feedback*
Tools.	**•What tools are available to bead tubing?** **•Is a lubricant required for beading?** **•What tubing materials can be beaded?** **•What is the alternative when the material cannot be beaded?**
Beading procedure.	**•Outline the procedure for beading a tube.** **•Describe the proper dimensions for a finished bead.**

Activities	*Check Items*
	Did the student:
Form a bead on two different diameters of tubing.	**•Select a material, alloy and temper which could be beaded?** **•Square the tubing ends and deburr before beading the tubing?** **•Select and correctly use the beading tools, i.e., correct mandrel to match tubing diameters, etc.?** **•Use lubricants as required?** **•Inspect the tubing beads for dimension, cracks, thin-out, deformation or gouges?**

FABRICATE FLARES ON TUBING.

(SEGMENT C, LEVEL 3)

Student Performance Goal

• Given:
Aluminum tubing, flaring tools and reference information pertaining to the flaring of tubing.

• Performance:
The student will form a single flare at one end of the tubing and a double flare at the other end.

• Standard:
The flares will meet MIL Specifications and be free of the defects identified in AC 43.13–1.

Key Points	*Feedback*
Tube flaring tools.	**•What tools may be used to flare aluminum tubing for aircraft type fittings?** **•What safety precautions should be observed when using flaring tools?** **•Why should flaring tools be kept clean and maintained in good condition?** **•Why is the degree angle of a flaring tool critical?** **•What is the difference between a single and a double flare?**
Tubing materials.	**•Name the materials from which tubing is manufactured.** **•What kind of flare could be formed on a soft aluminum tube of 3/8 inch diameter?** **•When the diameter of a tubing section is specified, does this identify the inside or outside diameter of the tubing?**
Flaring procedures.	**•Describe the procedure for cutting, de-burring and squaring a tube prior to flaring.** **•Identify the desirable features of a finished flare.** **•What problems will probably result from using steel wool to polish aluminum tubing?**

Activities	*Check Items*
	Did the student:
Form a single and double flare on a piece of aluminum tubing.	**•Select a material and temper condition that could be flared?** **•Use the correct tools and follow the correct procedure?** **•Inspect the completed flares and detect any defects present?**

FABRICATE AND INSTALL FLEXIBLE HOSES.

(SEGMENT D, LEVEL 3)

Student Performance Goal

• Given:
Field replaceable fittings, flexible hose, installation tools and appropriate reference information.

• Performance:
The student will identify and select the correct hose materials and fittings from stock, make-up and install a flexible hose assembly in a fluid system.

- **Standard:**
  The hose assembly and installation will be of such quality that it will function without leakage under the operating pressures of the system.

Key Points	*Feedback*
Tool selection.	•What tools are necessary to the field installation of fitting ends on flexible hose assemblies?
Material selection and storage of hose materials.	•What physical characteristics or appearance permits the identification of flexible hose materials? •How do AN and MIL specifications apply to the identification of hose? •What factors must be considered when estimating the length of a flexible hose? •What can be done to minimize the deterioration of hose while it is in storage? •What is understood by the term "shelf life" as applied to rubber products?
Installation of fittings.	•Why do flexible hoses have a linear stripe as part of the identification coding? •What methods are available for attaching fittings to flexible hoses? •Why are special tools recommended when installing the fittings on flexible hoses? •What precautions should be observed when installing fittings on flexible hoses?
Installation of flex-hoses in fluid systems.	•What hazards may exist while pressure proof-testing flexible hose? •How does internal pressure affect the length of a flexible hose? •Describe a procedure that will minimize the tendency of a flexible hose to loosen the coupling nuts at the fittings.

Activities	*Check Items*
	Did the student:
Identify and select hose and fittings.	•Select the correct hose as dictated by the system fluid and pressures.
Install fittings on hose.	•Correctly use tools and follow the correct procedure for installation of fittings?
Install and test hose in system.	•Install and inspect for return-to-service?

RECOGNIZE DEFECTS IN METAL TUBING.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  Random samples of metal tubing that may display defects that would cause the tubing to be rejected.

- **Performance:**
  The student will select one sample section of tubing that would be rejected due to each of the following defects:

  a. Deep scratches or dents.
  b. Flattened tube bends.
  c. Defective flare.

- **Standard:**
  The identification of samples containing defects will be without error.

Key Points	*Feedback*
Defects in tubing.	•What publications describe the limits to defects permitted in metal tubing? •How does a mechanic decide whether a tube should be repaired or replaced?
Repairing metal tubing.	•Describe the limits, tools and procedure to be followed in repairing scratched or dented metal tubing. •What repair procedure may be considered when the damage is limited to a single severe dent in a section of metal tubing? •Describe the general practices that will tend to reduce damage caused by maintenance mechanics to metal fluid lines.

Activities	*Check Items*
	Did the student:
Identify repairable/ rejected metal tubing samples.	•Measure and appraise the damage to reach the decision?

- Use reference information and correctly interpret specifications describing repairable defects?

INSTALL A SECTION OF TUBING.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- **Given:**
  Sections of replacement tubing and various fluid carrying systems installed in an airplane or mock-up and an appropriate manual.

- **Performance:**
  The student will install a replacement section of tubing as a procedure to repair the fluid systems. He will determine the proper routing and support of the tubing section by reference to the manuals, install the replacement tubing with AN, MS and hose clamp type fittings and make an operational check of the systems.

- **Standard:**
  The installation will be of such quality that the system functions normally and there is no leak in the replacement section of the system.

Key Points	*Feedback*
Routing of fluid lines.	•Why are fluid lines routed below electrical lines? •Why are fluid lines routed away from movable controls? •What special precautions should be observed in routing fuel lines through bulkheads, firewalls, entry-ways, crew compartments, baggage compartments?
Types of tubing connection.	•What is an AN fitting? •What is an MS flareless fitting? •What procedure is followed to install an MS fitting? •What is the disadvantage of using pipe-threaded fittings? •Why is tubing beaded? •When are flexible connections used?
Installation of fluid lines.	•What are the different types of securing devices used for supporting fluid lines? •Why are torque values required for fluid line connections? •What references are used to determine proper torque values for fluid line connections? •What governs the choice of lubricants when assembling line connections in the various fluid systems? •What determines the minimum bend radii for rigid tubing and for flexible hose? •What maximum reduction in original outside diameter is allowed when bending tubing for fluid lines? •What is the purpose of bonding fuel lines? •What are the means by which you might identify the tubing of a particular fluid system? •List and discuss the types of hose clamps. •What inspection aids or devices would an inspector employ when troubleshooting a fluid system?

Activities	*Check Items* Did the student:
Install sections of tubing in the system.	•Plan routing?

Activities	*Check Items* Did the student:
	•Identify and install fittings of the AN, MS and hose clamp types? •Identify supporting points? •Determine bonding required? •Apply proper lubricant and/or sealant to fittings? •Install tube or hose in mock-up? •Torque all connections? •Anchor and bond fluid lines? •Install identification markings?
Perform an operational check of the system.	•Cycle the system from an operational check list?
Inspect the replaced tubing section.	•Check for leaks, excessive vibration, chafing, clearance from moving parts? •Make a logbook entry? •Observe safety in pressurized systems by bleeding pressure before removing the tube?

18. PERFORM PRECISION MEASUREMENTS.

(EIT = 12 hrs., T = 2 hrs., L/S = 10 hrs.)
1 segment

(UNIT LEVEL 3)

INSPECT AIRCRAFT COMPONENTS FOR WEAR.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  Used and worn aircraft components including shafts, bearings, bearing journals, cylinders with associated pistons, connecting rods, crankshaft, sheet metal parts, and inspection tools, including micrometers, calipers, hole and snap gauges, dial indicators, "V" blocks, surface plates and written inspection data, blank report forms and status tags.

- **Performance:**
  The student will perform inspections using appropriate inspection tools to detect wear and/or deterioration in twenty used and worn aircraft components and complete typical report forms or status tags indicating acceptance or rejection of the inspected components.

- **Standard:**
  At least fifteen inspections and report forms will be completed in conformance with the written data provided.

Key Points	*Feedback*
Inspection concepts:	**•What is the difference between an ordinary micrometer and a vernier micrometer?**
a. Manufacturing (production) –production tolerances. –normal rejection factor. –statistical inspection. (spot-checking, normal curves, 100% inspection, quality control).	**•Name some of the precautions that should be observed when handling precision measuring instruments. •Describe the procedure used to calibrate a micrometer (gauge blocks). •Describe the difference between a hole snap-gauge and a ball gauge. Give examples of where these gauges might be used.**
b. Line maintenance.	**•Explain why go-no-go gauges are often used in place of other measurement techniques.**
Inspection.	**•Explain the meaning of the terms "nominal dimensions."**
a. Dimensional checks.	**•What is the difference between a manufacturing tolerance and a service limit? •Name the tools and describe the method that would be used to check the aligment of a shaft.**
b. Fits and clearances.	**•What care should be given a precision surface plate? Give examples of some abuses which should be avoided? •Describe the difference between a "tight" and a "loose" fit – as applied to precision measurements.**
Status report forms and/or tags.	**•What significance is associated with red, green and yellow status tags? •Who is responsible for determining whether a part is repairable, serviceable or rejected? •Why do status forms require serial numbers, time in service, etc?**

Activities	*Check Items*
	Did the student:
Use a micrometer to measure the outside diameter of: a. A shaft. b. A bearing. c. A bearing journal. d. The thickness of a thin sheet of steel or aluminum.	**•Select micrometer of size compatible with diameter to be measured? •Exercise care in handling both micrometer and parts being measured? •Take measurements at multiple positions to detect out of round? •Make written record of measurements?**
Measure a small hole in a typical aircraft part.	**•Select ball or snap gauge and micrometer of appropriate size? •Demonstrate "feel" in making measurement and exercise care for measuring tools? •Make written record of measurements?**
Read and interpret a vernier micrometer to measure the fit of: a. A ball or roller bearing into a machined recess.	**•Take multiple position measurements and make written record of measurements?**

Activities	*Check Items*
	Did the student:
b. The inner race diameter of a ball or roller bearing to a shaft.	•Locate manufacturer's table of limits and compare actual measurements?
c. A shaft into a friction (plain) bearing.	•Apply specifications in accepting or rejecting the inspected components?
d. A piston into a cylinder.	
e. A shaft into a machined hole.	
Use a dial indicator, "V" blocks and a surface plate to check the alignment of a shaft, a connecting rod and the "run-out" of a crankshaft.	•Use method or technique specified in manufacturer's manual? •Make written record of alignment measurement? •Apply specifications or tolerance in accepting or rejecting the component?
Use go-no-go and/or stretch gauges (as applicable) to inspect intake or exhaust valves, valve guides, machined threads, and machined bearing surfaces.	•Exercise care in handling tools and equipment? (Did not force or damage.) •Make written record of findings?
Record findings (dimension/fit/tolerance/remarks) on typical inspection report form or status tag.	•Sign the form? •Correctly identify the part? •Date and report and/or tag? •Indicate the reason for rejection?

19. IDENTIFY AND SELECT AIRCRAFT HARDWARE AND MATERIALS. (EIT = 38 hrs., T = 21 hrs., L/S = 17 hrs.) 8 segments

(UNIT LEVEL 3)

IDENTIFY AND INSTALL AIRCRAFT BOLTS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  A random display of aircraft quality bolts, a bolted installation problem on an aircraft powerplant or mock-up and written information.

- Performance:
  On an aircraft, powerplant, or mock-up, the student will determine the correct length of bolts to install some bolts with castle nuts and some with self-locking nuts and torque to correct values.

- Standard:
  Correctly identify ten different bolts from AN markings and by measurement and install bolts and nuts in accordance with return-to-flight standards.

Key Points	*Feedback*
Standard aircraft bolts and fasteners.	•What is the difference between AN and NAS close tolerance bolts? •What feature permits identification of an internal wrenching bolt? •How does a bolt differ from a screw?
Standard aircraft nuts.	•How does a castle nut differ from a self-locking nut? •How does a nut plate or anchor nut differ from a self-locking nut? •How can a mechanic distinguish between a shear nut and a castle nut? •Compare the physical characteristics of a checknut and a plain nut.
Machine screws.	•What are the head shapes of machine screws? •What is the difference between a stress screw and machine screw? •Why are machine screws available in both coarse and fine threads? •What materials are used in the manufacture of machine screws?
Studs.	•If a stud has both coarse and fine threads, which of the threads is tapped into the softer material? •Why aren't nuts on studs generally saftied with a cotter pin? •Describe the use of a step stud. •What is a helicoil?
P–K (self tapping) screws.	•What head shapes are available? •What types of recesses are provided for a screwdriver? •What finish is generally used to prevent rusting? •How does the strength of a P–K screw compare with a machine screw?

	•What is a tinnerman nut?
Locking devices.	•From what materials are cotterpins made? •What are lock washers? •Explain how tab and spring type washers act to safety a bolt-nut installation. •What are roll pins? How are they secured? •What are pal-nuts? •How do you remove and install a circlip? •What materials are used for safety wire?
Machine screw threads.	•What is meant by the term "NC" thread? •Is the thread on a hex head aircraft bolt a coarse or fine thread? •Interpret the following thread designations: #10–32NF ¼–28NF # 6–32NC •How can the tap drill size for a particular thread be determined? •How can a mechanic determine a clearance drill size for a specified thread? •What is meant by a Class 3 thread fit?
AN and NAS numbering systems.	•How can the dimensions for AN and NAS bolts and screws be determined? •In what fractional increments are the diameters of bolts measured? •In what fractional increments are the lengths of bolts measured?
Special purpose bolts: a. Close tolerance. b. Internal wrenching. c. Corrosion resistant.	•Cite some examples of where a close tolerance bolt would be used. •What kind of finish is common to a standard AN steel bolt? •Name several kinds of internal wrenching bolts. •Why aren't corrosion resistant bolts plated?
Head markings on bolts.	•What would an "X" or a "+" or asterisk indicate as a head marking on a bolt? •Identify each of the following symbols that might appear on a bolt: –a single dash. –a double dash. –triangle. –circle.
Color coding of bolts.	•What color is used to indicate magnaflux, zyglo or X-ray inspection of bolts?
Determining bolt length.	•Why are washers used in bolt-nut assembly operations? •What problems would occur if the threaded portion of the bolt had bearing on the bolt hole in the part? •What is grip length of a bolt? •How does grip influence bolt length?
Selection and use of self-locking nuts for specific applications.	•How does temperature influence the selection of a self-locking nut? •If a bolt-nut installation will be subject to rotation, what kind of nut should be used? •In what manner does a drilled shank bolt effect the installation of a self-locking nut? •What are the limitations to the use of and re-use of a self-locking nut?
Torque values.	•If you found different torque values specified in the manufacturer's manual, than those specified in FAA publications, which values would you adhere to?
Measurement values.	•Explain how you would convert inch-pounds to foot-pounds. •What stresses are considered when torque values are specified for a particular diameter of bolt?

Activities	*Check Items*
	Did the student:
Select steel bolts from random display.	•Recognize head identification markings? •Interpret AN or NAS codes in specifying diameter, length and material?
Determine and obtain correct length bolt for the specific installation.	•Select correct grip length?

Install bolt, washer and nut.	**•Allow for correct exposure of thread through self-locking nut and/or position of cotter pin hole in castellation of nut?**
Torque and safety.	**•Interpret specification of torque values?**

IDENTIFY ALUMINUM ALLOYS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
A random display of sheet aluminum samples including at least ten different alloy types and written aluminum alloy reference data.

- **Performance:**
The student will identify ten samples of the various family groups of aluminum alloy by visual recognition of code designators and select appropriate alloys for ten specified aircraft applications.

- **Standard:**
Correctly select at least eight aluminum family group samples and at least eight alloys for specified applications.

Key Points	*Feedback*
Old and new code numbering systems.	**•Why was the code numbering system changed?** **•What comparison may be made between the two code systems?** **•What general cross reference exists between the two coding systems?**
Alloy identification.	**•Considering commercially pure aluminum as the base, approximately what percentage of alloy is added to develop the typical heat treatable aluminum alloy?** **•How does the code system identify the major element in an aluminum alloy?** **•What parts of the airplane are manufactured from heat treatable aluminum alloys?** **•What aluminum alloys are commonly used for welded fuel tanks?** **For fairings and cowlings?** **•Which of the alloys are both weldable and heat treatable?** **•Which of the alloys are used for rivets?**
Hardness identification.	**•Explain why a sheet of aluminum would not be identified as 1100S–T4.** **•If it was necessary to form, bend or shape a piece of heat treatable aluminum, in what temper condition would the material be ordered?** **•What happens to all aluminum alloys when they are hammered, bent or shaped?**
Alclad/pureclad identification.	**•What code markings indicate that an aluminum alloy has a clad finish?** **•What is the average thickness of a clad surface?**

Activities	*Check Items*
	Did the student:
Select aluminum alloy sheet and/or extrusion from displayed samples, identifying the alloy and hardness.	**•Promptly recognize materials?** **•Note alloy identification?** **•Note hardness designation?**
Describe the application of an identified material for repairs to: **a. Stressed skin.**	**•Note material identification on original structure and/or referenced material specification in the manufacturer's structural repair manual?**
b. Internal structure.	**•Make determination of difference in strengths if an alternate material is being used in lieu of original?**
c. Cowlings/fairings.	
d. Secondary structure.	**•Show awareness of cladding in both original structure and selected repair material?** **•Correctly select a material which could be severely formed?**

IDENTIFY STEEL ALLOYS.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
Random selection of aircraft steel alloy tubing and sheet, and SAE or AISA code publications.

- **Performance:**
  The student will identify the SAE code markings and, referring to the SAE or AISA publications, interpret the coding for ten samples.

- **Standard:**
  Identification of material and interpretation of code will be without error.

Key Points	*Feedback*
SAE code identification system.	•What does each digit in the SAE code system indicate? •Why doesn't a low or mild carbon steel respond to heat treatment?
Uses of aircraft steel.	•Why are nickel alloys used in hardware? •From what materials are flying and landing brace wires made? •Can the alloys of a steel be identified by grinding the material against a grinding wheel? •Describe some of the methods which can be used to identify a stainless steel.
Code markings on steel alloys.	•How can an alloy steel be identified if there are no markings or color coding on the material?
Identifying temper conditions.	•In what ways is annealing like normalizing? •In what ways do the processes differ?

Activities	*Check Items*
	Did the student:
Identify samples of steel alloy tubing and sheet by interpreting code markings.	•Correctly interpret the code markings?

RECOGNITION OF ECONOMIC AND ENGINEERING CRITERIA IN SELECTION OF AIRCRAFT MATERIALS.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information and a series of questions, with multiple choice answers, concerning the economic and engineering criteria involved in selection of materials for specific aircraft applications.

- **Performance:**
  The student will select answers for thirty questions covering the economic and engineering criteria involved in selecting materials for specific aircraft applications. The questions will be concerned with shaping and forming of metals, joining of materials, composition of metal alloys, plastics, and rubber, and the determination of the mechanical properties of materials.

- **Standard:**
  Select correct answers for at least twenty-one questions.

Key Points	*Feedback*
Selection of materials as dictated by design of the airplane: a. Speeds. b. Cost factors. c. Maintainability and service life. d. Weight.	•Although airplanes are constructed primarily of aluminum, why is there an increasing use of honeycomb, titanium and fiber filament type laminates? •What is meant by the terms fatigue life or "limiting cycles"? •Describe the ways in which a structure may be considered "fail-safe." •Compare the fatigue life of a riveted vs. a bonded joint. •What advantages does a forging have over a "built-up" structure? •Does pressurization have any affect on the fatigue life of an airplane? •In your own words, describe some of the problems associated with: a. Sharp notches in a high stressed structure. b. Eccentrically loaded fittings. c. Repeated cyclic loads.
Shaping of metals: a. Casting.	•What strength may be expected in a cast part? •Why is the finish and appearance of a sand cast part inferior to a die cast part? •What is the advantage of a centrifugally cast or investment cast part? •What metals may be cast? •What precautions are necessary when installing a cast part?

	•Explain why cast parts may fail under a sharp blow or impact.
b. Forging.	•How does the forging process improve the strength of the part? •Distinguish between open forging and die forging. •What factors limit the size of parts that may be forged?
c. Extrusion.	•Compare the qualities of an extruded tube and a seam welded tube. •Why is the extrusion process so adaptable to the production of wire and shaped solid extrusions?
d. Powder metallurgy.	•What are the limitations imposed on the production of powder metal parts? •What is meant by the term "sintered"? •What parts of an airplane may be produced from powdered metal? •What precautions must be observed when installing an "oilite" bearing?
e. Rolling, spinning, stretch forming.	•Describe why a propeller dome may be produced by spinning and a section of cowl stretch formed. •What process would be used to produce a sheet metal stringer?
f. High energy forming processes.	•How did the development of some of the newer metals make new forming processes necessary? •What forms of energy are utilized in these forming processes?
Joining of materials.	•What affect does vibration have upon joints in metals? •Explain why a joint should avoid stress concentrations. •Why are eccentric loads to be avoided? •What are the disadvantages of bolted and riveted joints? •What are the limits in joining metals by welding/brazing/soldering? •Why has bonding and expoxy gluing gained wider acceptance?
Aircraft materials:	
a. Metals and alloys.	•How is iron extracted from iron ore? •What is meant by the term "alloy"? •What is the difference between a chemically pure and a commercially pure metal?
b. Iron and steel.	•How does the addition of carbon to iron affect the hardness of the metal? •What is meant by the term "heat-treatment"? •What distinguishes iron and steel? •What is the difference between a case-hardened steel part and a nitrided steel surface?
c. Aluminum alloys.	•How do the strength to weight ratios of aluminum and steel compare? •Compare the corrosion resisting characteristics of aluminum and steel. •What metals are alloyed with aluminum?
d. Other metals and alloys.	•Arrange the following metals: magnesium, nickel, copper, brass, bronze, tin and titanium in a descending order of strength. •Why is the use of titanium finding increased applications in the aircraft industry?
e. Plastics.	•What is the difference between a thermal setting and a thermal softening plastic? •What is meant by the term "plastic memory"? •Where are nylon parts used in the construction of an airplane? •What are some applications of parts made from polyesters and polyvinyls? •Give one example of an airplane part made from fiberglass, asbestos and ceramics.
f. Rubber.	•Name some parts of the airplane that would be made from natural rubber. •Describe some of the precautions that would be observed in storing rubber products.

	•How does the resiliancy of natural rubber compare with synthetic rubber? •What are some of the advantages of synthetic rubber over natural rubber? •What physical characteristics would indicate aging in rubber products?
g. Mechanical properties of materials.	•Give some examples of aircraft parts and materials that would display high tensile strengths. •Give an illustration of ductility in materials. •What term would describe a material that returns to its original shape following stretching? •Compare ultimate strength and margin of safety. •What is a safety factor? •How could a shear test be made? •If a material has the ability to resist impact loads, what term could be used to describe this material? •Under what environmental conditions would a material probably creep and fatigue?
h. Mechanical testing of materials.	•What are the names of some of the machines used to measure tensile strength of materials? •Can tensile tests indicate whether a part has been heat treated? •How could a machine measure the shear strength of a material?

IDENTIFY RIVETS BY PHYSICAL CHARACTERISTICS.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  A random unlabeled display consisting of 30 different types of AN, MS, NAS and trademark aircraft rivets and standard rivet publications.

- **Performance:**
  The student will identify each rivet by head shape, alloy, dimensions, and where applicable, type letter designating strength characteristics. He will answer ten questions concerning use limitations for certain types of rivets, chilling, "age hardening," and which types of rivets need heat treatment.

- **Standard:**
  Correctly identify at least twenty-five types of rivets and correctly answer at least eight questions.

Key Points	*Feedback*
The AN rivet code system.	•What is meant by the term "protruding head" rivets? •Explain what is meant by a "flush head" rivet. •Compare the strengths of a round, flat, brazier and flush head rivet of equal diameter. •What fractional increments are used in measuring rivet diameters? Lengths? •What feature in the head of a rivet identifies the alloy from which the rivet is manufactured?
The MS rivet numbering system.	•What rivet head type utilizes an MS number?
NAS and trademarked rivets.	•How are size and material designated for NAS rivets? •Describe Cherry rivets. •Where are Huck rivets used? •What are some aircraft uses of Hi-shear rivets?
Limitations in uses of rivets.	•What are some of the factors which might cause a rivet to split while being driven? •What is a type "A" rivet and what is the importance of being able to identify a rivet manufactured from this material?
Rivet strength control methods.	•Why are rivets manufactured from 2024 and 2017 aluminum alloy referred to as "ice box" rivets? •Explain the process of "age hardening" during which a rivet develops its full tensile strength. •Why is it unnecessary for an A17S alloy rivet to be heat-treated.

IDENTIFY MATERIALS USED IN AIRCRAFT FIREWALLS AND EXHAUST SHROUDS.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
  Written technical information and samples of materials suitable for use in aircraft firewalls and exhaust shrouds.

- **Performance:**
  The student will identify six samples of materials suitable for use in aircraft firewalls and exhaust shrouds. He will use pertinent technical reference information or aircraft manuals to illustrate the suitability of the materials.

- **Standard:**
  At least five materials will be correctly identified and at least five applications correctly listed.

Key Points	*Feedback*
Materials used for firewalls.	• What general rules apply to materials suitable for use in firewalls and shrouds? • What types of stainless steels are commonly used for firewalls and shrouds?
Thickness of materials.	• Under what conditions would an aluminum alloy be considered as an appropriate material for a shroud?
Materials approved for use on shrouds and manifolds.	• Why would an annealed stainless steel be used as a material for a firewall? • Compare the properties of galvanized steel terneplate. • What substitutes can be made if the original materials of a firewall or shroud cannot be identified?

Activities	*Check Items* Did the student:
Identify firewall materials.	• Correctly interpret information from the manuals and identify the materials?

DETERMINE SUITABILITY OF MATERIALS FOR AIRCRAFT REPAIRS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- **Given:**
  Written technical information and sample materials for structural aircraft repairs.

- **Performance:**
  The student will select suitable materials for use in aircraft structural repairs to pressurized sections of a fuselage, fuel cell areas, wing rib sections, flight control surfaces and honeycomb or laminated structures. He will use and interpret information pertaining to the specific types of repairs.

- **Standard:**
  Proper selection of material in conformance with technical information provided.

Key Points	*Feedback*
Sources of pertinent information.	• Where would the student look for data pertaining to repairs in the pressurized sections of an aircraft fuselage? • Why are structural repairs in the fuel cell areas of a wing particularly critical?
Stress analysis.	• Determine if the sealant used in accomplishing repairs to a pressurized airplane met an air-worthiness standard.
Structural strength considerations.	• Under what conditions might an annealed aluminum alloy sheet be used in the repair of an aircraft structure? • Where would the student find information pertaining to the repair of a wing rib? • While making a repair to a flight control surface, what other considerations in addition to materials would be advisable? • Where would the student look for information relative to the repair of honeycomb and/or laminated structures?

Activities	*Check Items* Did the student:
Interpret specifications and identify materials.	• Correctly interpret the specifications?

IDENTIFY AIRCRAFT CONTROL CABLE.

(SEGMENT H, LEVEL 3)

Student Performance Goal

- **Given:**
Written technical information and samples of aircraft control cables including non-flexible, flexible and extra-flexible types.

- **Performance:**
The student will identify six different samples of aircraft control cable as to type of cable, number of strands, number of wires per strand, material, and whether preformed or non-preformed.

- **Standard:**
Correctly identify at least five samples.

Key Points	*Feedback*
Types of cable construction.	**•Why is a 7 x 19 control cable more flexible than a 7 x 7 cable of the same diameter?** **•What is the purpose of having a core strand?** **•Why is there less "stretch" in a 1 x 19 cable than in a 7 x 19 cable of equal diameter?**
Materials and forming.	**•How can a magnet be used to identify the material?** **•Which cable would have greater strength, a carbon steel or corrosion resistant steel cable?** **•While cutting a piece of control cable, how would the student determine if the cable was preformed or non-preformed?**

Activities	*Check Items*
	Did the student:
Identify samples of control cables.	**•Count the number of strands?** **•Identify the core strand?** **•Count the number of wires in each strand?** **•Identify the helix of a preformed strand?** **•Use a magnet to identify material?**

20. PERFORM BASIC HEAT – TREATING PROCESSES. (EIT = 6 hrs., T = 5 hrs., L/S = 1 hr.) 4 segments

(UNIT LEVEL 2)

EFFECTS OF HEAT TREATMENT.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
Written technical information and questions with multiple choice answers concerning the effects of various forms of heat treatment on metal alloys.

- **Performance:**
The student will select correct answers for ten questions concerning the relationship between tensile strength and metal hardness, how hardness and tensile strength are determined, the effects of heat treatment processes on aluminum alloys, and the results of incorrect heat treatment procedures.

- **Standard:**
Select at least seven correct answers.

Key Points	*Feedback*
Relationship between hardness and tensile strength.	**•By what methods are aluminum alloys checked for tensile strength?** **•Could hardness testing be used to indicate whether an aluminum alloy has been heat treated?**
Testing for hardness.	**•In general, how do hardness testing machines operate?** **•How can hardness of a material be identified by feeling or bending?** **•How can the tensile strength and hardness be determined from code numbers on aluminum alloy?**
Methods of hardening aluminum alloys.	**•What processes are used to harden aluminum alloys?** **•Explain the effectiveness and applications of each process for aircraft aluminum alloys?**
Results of incorrect procedures.	**•What conditions may be caused by incorrect heat treatment?** **•Define blistering, exfoliation, intergranular distortion, discoloration.** **•What are the effects on the corrosion resistant properties of aluminum alloys from improper heat treatment?**

IDENTIFY ALUMINUM ALLOY CODE DESIGNATION OF HEAT-TREATABILITY.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Samples of aluminum alloy sheet and AC 43.13–1 or equivalent written data concerning identification of aluminum alloys.

- **Performance:**
  The student will identify samples of aluminum alloys, at least five of which are considered heat-treatable, five nonheat-treatable, and three with trademarks indicating surface corrosion prevention treatment.

- **Standard:**
  Correctly identify at least two types of heat-treatable aluminum alloys, at least three types of nontreatable, and two types with surface corrosion prevention treatment.

Key Points	*Feedback*
Aluminum alloy codes.	• What code numbers appearing on a sheet of aluminum alloy indicate heat treatable alloys? • Which code designators indicate the degree of heat treat? • Degree of hardness? • Combination of both?
Aircraft applications.	• Name the common aluminum alloys used in aircraft construction. • How is surface corrosion prevented in aluminum alloy sheet for aircraft uses? • How can the degree of temper for aluminum alloys be determined from code designators?

Activities	*Check Items* Did the student:
Read and interpret code designators on aluminum alloy sheet.	• Include all parts of the code designator? • Interpret meaning of surface treatment trademarks? • Use proper tables to determine meaning of code designators.

HEAT TREATMENT PROCESSES AND STRAIN RELIEVING.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- **Given:**
  Written technical information and questions concerning heat treatment processes, tempering, and strain hardening of metals.

- **Performance:**
  The student will answer five questions concerning the steps in heat treatment of aluminum alloys, five questions concerning the effect of heating a metal such as steel slightly above its critical temperature, then cooling it rapidly, and five questions concerning strain hardening and its effect on the tensile strength of aluminum alloy.

- **Standard:**
  Correctly answer at least three questions in each of the three categories.

Key Points	*Feedback*
Types of aluminum alloys.	• Name the common types of aluminum alloys used in aircraft construction. • What is the composition of each alloy named?
Types of heat treating processes.	• Define heating, heat soaking, quenching, annealing and aging. • For what metals are annealing processes most practical? • Define hardening, stress relieving, tempering, normalizing and drawing.
Heat treatment of	• What happens when steel is heated slightly above its critical temperature (molecular structure effects)? • What happens if the metal is then rapidly cooled (quenched)? • When does tempering take place?
Strain hardening of aluminum alloy.	• What happens to aluminum alloy during strain hardening? • How is strain hardening accomplished? • What happens to the hardness of aluminum after strain hardening?

ANNEAL COPPER AND STEEL PARTS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Samples of copper tubing and welded steel parts, an oven or torch and written procedural information.
- **Performance:**
  The student will use an oven or torch to anneal a piece of copper tubing and to stress relieve a welded steel part.
- **Standard:**
  The annealed copper tubing will be capable of being formed around a radius equal to three times the diameter. The steel part will be bent in a vise to provide evidence of the stress relieving.

Key Points	*Feedback*
Hardening of copper.	•What causes age hardening of copper? •Why is it important to detect copper tubing or parts that have hardened?
Annealing process.	•What effect does annealing have on hardened copper? •How is annealing accomplished? •How are thermocouple gaskets annealed? •Is it necessary to clean copper after annealing?
Stress relieving of welded steel parts. ("Normalizing" or "stress annealing")	•How does welding cause stresses? •What results when excess stresses are developed? •Describe the process that is used to relieve stress resulting from welding. •What is the quenching agent used, if any? •What is the molecular change desired?

Activities	*Check Items*
	Did the student:
Heat test specimen of copper to red heat and quench in water.	•Draw attention to change in color as copper is annealed? •Check for hardness or brittleness by bending?
Heat steel specimen above critical range and quench in water or oil.	•Show awareness of the identity of specimen being heated and quenched?
	•Remove scale from specimen to provide bright surface so color may be observed as temper is drawn? •Give emphasis to the correct cooling rate?

21. PERFORM PENETRANT, CHEMICAL ETCHING, AND MAGNETIC PARTICLE INSPECTIONS.

(EIT = 12.50 hrs., T = 4 hrs., L/S = 8.50 hrs.)
4 segments

(UNIT LEVEL 2)

PERFORM DYE PENETRANT INSPECTION.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  A specimen aircraft part with known invisible surface cracks, a dye penetrant inspection kit with applicable operating instructions, and AC 43.13–1 or an equivalent publication.
- **Performance:**
  The student will prepare the specimen part for inspection, apply and remove the penetrant, apply developer, inspect for cracks, and complete after inspection cleaning.
- **Standard:**
  Perform all steps in accordance with instructions and locate at least one crack.

Key Points	*Feedback*
Dye penetrant inspection.	•Explain the principle of dye penetrant inspection. •Why must the areas to be inspected be thoroughly cleaned, including any anodizing, before applying dye? •Approximately how long should the dye be left on the surface before it is removed? •What is the purpose of the developer? •What benefit results from heating a part that is to be inspected?
Use of fluorescent type dye penetrant (zyglo).	•Why do some dye penetrant inspection procedures use a "black-light" as part of the inspection?

	•What are the limitations of fluorescent dye penetrant? •Why should a magnifying glass be a part of the inspection equipment?
Chemical etching.	•When a flaw has been detected, what is the value of using chemical etching to determine the extent of the flaw?

Activities	*Check Items*
	Did the student:
Clean and prepare specimen for dye penetrant inspection.	•Adhere strictly to the operating instructions? •Clean the specimen thoroughly?
Apply dye penetrant.	•Spread the dye penetrant evenly over all of the area to be inspected?
Remove dye penetrant.	•Wipe off all visible dye penetrant?
Apply developer.	•Apply the developer evenly over all of the area?
Inspect for cracks and pin-holes.	•Adequately illuminate all areas to be inspected? •Use optical aids, if provided, to assist in finding hairline cracks?
Clean after inspection.	•Remove all developer from specimen after inspection?

PERFORM MAGNETIC PARTICLE INSPECTION.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  A steel aircraft part having a known sub-surface flaw or fracture, magnetic particle inspection equipment, applicable operating instructions, and AC 43.13–1 or an equivalent publication.

- Performance:
  The student will use the magnetic particle inspection method to locate and identify a sub-surface flaw or fracture and properly demagnetize the part after completing the inspection.

- Standard:
  Perform all steps in accordance with instructions provided, locate and identify at least one flaw or fracture.

Key Points	*Feedback*
Magnetic particle inspection.	•Describe briefly, the principle of wet and dry magnetic particle inspection. •What type of visual indication is provided? •Compare the features of Magnaflux vs. Magnaglo.
Limited to inspection of iron or steel parts.	•Why is magnetic particle inspection impractical to detect cracks in aluminum alloy forgings and castings?
Demagnetization and clean up after in-	•Why are parts demagnetized following inspection? •How is demagnetization accomplished? •Why is cleaning of a part required after magnetic particle inspection?

Activities	*Check Items*
	Did the student:
Magnetically inspect a part having a subsurface flaw.	•Show awareness of limitations in reading and interpreting indications? •Properly demagnetize the part after inspection?

PERFORM INSPECTIONS OF WELDED ASSEMBLIES.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  Samples of aircraft welded assemblies which have known cracks and/or blow-holes not easily visible to the unaided eye, magnifying glass (10 power or greater), dye penetrant or Zyglo test equipment, magnetic particle test equipment, AC 43.13–1 or equivalent publication and operating instructions for the test equipment.

- Performance:
  The student will locate cracks and/or blow-holes in each of five welded assemblies using a magnifying glass, dye-penetrant, and magnetic particle tests as applicable for the kind of material being tested.

- Standard:
  Locate and identify flaws in at least three of the welded assemblies and perform inspection in accordance with instructions provided.

Key Points	*Feedback*
Importance of finding flaws in welds.	**•Where are cracks generally found in a weld?** **•How might the presence of blow-holes be suspected?**
Aircraft structures involved.	**•Which types of welded aircraft structures are susceptible to these flaws?** **•Why are gear, wing and engine mount attachments especially critical as to weld flaws?**
Types of inspection.	**•Which type of inspection is most suitable for aluminum welds?**
a. Dye penetrant and Zyglo.	**•Where is the magnetic particle method most suitable?**
b. Magnetic particle method.	**•Can a portable magnetic particle inspection unit be used? How is the area demagnetized?**
c. X-ray.	**•What limits the use of the X-ray for weld inspections?**
d. Optical aids.	**•How important is a good magnifying glass as an aid to most types of inspection?** **•What limits the amount of magnification power that can be used in optical aid inspections?**

Activities	*Check Items*
	Did the student:
Test samples of aircraft welded assemblies for cracks and/or blow-holes.	**•Clean the surface of the weld properly?** **•Apply the dye penetrant materials in the proper manner?** **•Perform proper cleanup after completing the test?**
Test steel welds by the magnetic particle method.	**•Prepare the area to be tested properly?** **•Use the magnetic test equipment with proper care and caution?** **•Demagnetize the tested material after testing?**

PERFORM TESTS TO DISTINGUISH BETWEEN HEAT TREATABLE AND WELDABLE ALUMINUM ALLOYS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information concerning aluminum alloy identification, samples of heat treatable and weldable aluminum alloys which lack legible code markings, and a kit of testing chemicals for aluminum alloy identification.

- **Performance:**
  The student will perform tests on six samples of aluminum alloy to determine and mark those which are heat treatable and those which are weldable.

- **Standard:**
  Correctly test and mark at least two samples of heat treatable and two samples of weldable aluminum alloy.

Key Points	*Feedback*
Identification of unmarked (or illegibly coded) aluminum alloys.	**•What is the primary difference in alloys that are used in a heat treatable aluminum and the alloys used in a weldable (nonheat treatable) aluminum alloy?** **•What chemical may be used to distinguish between heat treatable and weldable aluminum alloys?** **•Are there any detrimental effects to aluminum as a result of etching with caustic soda?** **•What procedure may be used to neutralize the etch?**

Activities	*Check Items*
	Did the student:
Immerse sample pieces of aluminum alloy in a 10% solution of sodium hydroxide.	**•Observe safety considerations in handling the caustic mixture?** **•Recognize reaction at edge of Alclad sheet?**
Neutralize following etch.	**•Select the correct neutralizing agent?**

22. INSPECT AND CHECK WELDS. (EIT = 5 hrs., T = 1 hr., L/S = 4 hrs.) 1 segment

(UNIT LEVEL 3)

INSPECT AND EVALUATE WELDS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  Assorted aircraft welded assemblies of acceptable and unacceptable quality, written information concerning welding including AC 43.13–1 or equivalent publication.

- **Performance:**
  The student will inspect and evaluate the quality of the weld in each of ten welded aircraft assemblies. He will point out any faults or defects in each weld and decide whether it is acceptable or should be rejected.

- **Standard:**
  Decision of acceptance or rejection will be correct for at least 8 welded assemblies and at least 80 percent of the defects and flaws pointed out will be valid in accordance with written information provided.

Key Points	*Feedback*
Desirable characteristics of a completed weld.	•What width should the welding bead have? •What should be the depth of penetration? •Describe a completed weld of good quality.
Undesirable characteristics.	•What are some of the faults that you would associate with a "cold" weld? •What are some of the defects that you might expect with a "hot" weld?
Stresses in welded joints.	•Describe the effect of expansion during welding. •What action can be taken to reduce or minimize the effects of distortion and residual stress resulting from welding?
Unacceptable defects.	•What constitutes an unacceptable defect: Relate in terms of: a. Insufficient width. b. Lack of penetration. c. Poor fusion. d. Burning/pitting. e. Blow-holes. f. Projecting globules.
Re-welding a previously welded joint.	•What is necessary to prepare a previously welded joint for rewelding. •What may be the effect of reheating the welding material?

Activities	*Check Items* Did the student:
Inspect welded aircraft assemblies.	•Use magnifying glass? •Refer to published information in making his evaluations?
Check for depth or extent of flaws.	•Use dye-penetrant to check extent of questionable defects? •Show an understanding of what constitutes a good weld? •Check for indication of unrelieved stresses in the weld?

23. IDENTIFY AND SELECT APPROPRIATE NONDESTRUCTIVE TESTING METHODS.

(EIT = 7.0 hrs., T = 7 hrs., L/S = 0 hrs.)
1 segment

(UNIT LEVEL 1)

SELECT NONDESTRUCTIVE TESTING METHOD.

(UNIT LEVEL 1)

Student Performance Goal

- **Given:**
  Written descriptions of six typical aircraft defects or flaws including engine crankshaft flaws, surface cracks in aluminum castings and forgings, cracks in materials where only one side of the material is accessible, component defects requiring radiography or X-ray inspection for proper detection, and written information concerning nondestructive testing.

- **Performance:**
  The student will select which method of testing is best suited for detection and evaluation of each described defect or flaw and briefly state how the inspection should be accomplished.

- **Standard:**
  Select proper method for at least four of the described defects or flaws and at least four statements of how inspection is to be done to be in accordance with written information provided.

Key Points	*Feedback*
Nondestructive inspection.	•Explain the purposes of nondestructive testing and inspection. •Name at least four basic methods of nondestructive testing.

Detecting defects in aluminum castings and forgings.	•What are some of the causes for cracks in aluminum castings and forgings? •How is dye penetrant used as an inspection method? Will it be effective in detecting both internal and surface defects? Explain. •What advantages would X-ray offer over dye penetrant inspection of an aluminum forging?
Magnetic particle inspection.	•Name some of the materials which can be magnetically inspected. •Why are the magnetic particle methods especially suitable for engine crankshaft inspection?
Magnaflux and Magnaglo.	•What is the difference between Magnaflux and Magnaglo inspection methods? •What are some of the limitations in the reading and interpreting of magnaflux and magnaglo indications?
X-ray or radiograph inspection.	•What are some of the situations in which X-ray is used for aircraft inspection? •Compare with other nondestructive methods of inspection and show limitations and advantages. •What are some of the limitations imposed on the operator of X-ray equipment? •What is the hazard of exposure to radiation? •What safety precautions should be observed when X-ray inspections are being conducted? •Who is qualified to read and interpret X-ray pictures? •If only one surface or side of a part is exposed, what inspection methods could be used?
Ultrasonic inspection.	•Describe the difference between X-ray and ultrasonic inspection. •Name some of the aircraft parts which are normally inspected by ultrasonic inspection procedures. •Where is eddy-current inspection most generally used?

CLEANING AND CORROSION CONTROL

24. IDENTIFY AND SELECT CLEANING MATERIALS.

(EIT = 12 hrs., T = 4 hrs., L/S = 8 hrs.) 2 segments

(UNIT LEVEL 3)

IDENTIFY CAUSTIC CLEANERS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

• Given:
Samples of caustic cleaners and aluminum alloys.

• Performance:
The student will apply caustic cleaning materials to the aluminum alloy samples and observe the effects of varying soak times. He will recognize and point out damage due to excessive strengths and soak times should they appear in the samples being cleaned.

• Standard:
From a display of aluminum alloy samples, the student will recognize those samples that have been damaged by excessive cleaning.

Key Points	*Feedback*
Caustic cleaning of aluminum structures.	**•What is corrosion?** **•How does electro-chemical differ from chemical cleaning?** **•Name four forms of corrosion and discuss the causes of each.** **•How can corrosion be prevented?** **•What is a caustic cleaner?** **•Name several compounds commonly used for cleaning that you would consider caustic.** **•Why are chemical-water and solvent emulsion cleaners preferred?** **•Where should caustic cleaners be avoided?** **•What safety precautions should be observed when handling caustic cleaners?**

Activities	*Check Items*
	Did the student:
Apply caustic cleaners to sample aluminum alloy sheets.	**•Observe safety precautions in handling:** **a. Sample aluminum parts?** **b. Samples of caustic cleaning products?**
Observe chemical reaction.	**•Demonstrate the effects of caustic cleaning solution on aluminum parts in relation to time of exposure and strength of solution?** **•Make a list/chart showing solution strength and soak time to prevent damage to aluminum parts?**
Recognize damaged samples and describe cause of damage.	**•Avoid splashing the solution onto personnel?**

IDENTIFY CLEANING AGENTS FOR AIRCRAFT ENGINE PARTS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

• Given:
Manufacturer's information sheets, manuals, product catalogues, and typical aircraft and engine parts.

• Performance:
The student will use the reference information to guide his selection of the correct cleaning material for steel, aluminum, titanium, and magnesium parts. He will demonstrate his ability to identify and use approved cleaners and brighteners.

• Standard:
The student will interpret information from the reference manuals and catalogues without error. He will correctly identify packaged cleaning and brightening agents and follow printed instruction for use of such products.

Key Points	*Feedback*
Characteristics and use of chemical cleaners.	**•What are the petroleum products used in cleaning?** **•What is a vapor degreaser? Explain its use.** **•List several instances where steam can readily be employed as a cleaner.** **•Why must time be a variable in the use of many chemical cleaners?** **•List several commonly used chemical cleaners and a quick means of neutralizing their action.**

- List several chemical cleaners that might be employed on plastic.
- What precautions would be taken when using a stripper in an area containing plastics?
- Why should external surfaces that have been steam cleaned be thoroughly rinsed with plain water?
- What is a fayed surface and why do they cause concern in cleaning?
- What is the recommended pressure range when spraying solvents in a cleaning operation?
- What materials may be damaged by caustic cleaners?
- What effect would soap solutions used for cleaning have on an engine if residue remained in the oil passages?
- What factors govern the use of vapor blasters in cleaning?
- What is a brightening agent?
- What precautions should be observed when working with brightening agents?
- What is a neutralizer?
- Why is it considered poor practice to use wire wheel, knives, scrapers or abrasives when cleaning high strength metal parts?

Cleaning of engine parts.

- What are the advantages and disadvantages of blasting engine parts with:
  a. Sand?
  b. Walnut shells?
  c. Hard shell grain?
  d. Plastic pellets?
- Where could the metal wools be used in the cleaning of engine parts?
- Name the stripping solution that might be employed to remove carbon.
- What precautions should be taken with aluminum and magnesium when using alkaline-caustic solutions?
- What precautions should be taken when using trichlorethylene (vapor) solutions?
- What is sonic cleaning and where might it be employed?
- What limitations are placed on the use of abrasives in the cleaning of engine parts?

Activities	*Check Items* Did the student:
Identify chemical cleaners to clean parts.	• Identify chemical cleaners? • Use face shield, apron and gloves? • Demonstrate the effects of chemical cleaners on aircraft materials in relation to time of exposure and strength of solution? • Observe appropriate safety procedure when handling chemical cleaners? • Demonstrate the mixing of a chemical solution? • Demonstrate the effect of chemicals on protective materials? • Demonstrate the removal of chemical solution in case of splash?
Clean typical engine parts.	• Demonstrate knowledge of cleaning methods and materials? • Use face shield? • Use gloves and apron? • Identify the various cleaning materials?

25. PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL. (EIT = 26 hrs., T = 8 hrs., L/S = 18 hrs.) 6 segments

(UNIT LEVEL 3)

CLEAN EXTERIOR OF AIRCRAFT.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Appropriate cleaners and equipment.

- Performance:
  The student will select and employ the correct materials and clean the exterior surfaces of an airplane.

- **Standard:**
  The task will be accomplished without damage to the finish and components or systems of the airplane.

Key Points	*Feedback*
The effects of dirty exterior surfaces on high speed performance.	• How does an airfoil produce lift? • What is meant by lift-drag ratios? • Describe skin friction.
Cleaning materials and procedure.	• How will grease, dirt, or surface deformities caused by these materials disrupt laminar flow? How will this reduce speed? • How is the oil and dirt removed without harming the airplane finish?

Activities	*Check Items* Did the student:
Cleaning an airplane.	• Use cleaning rags and insure removal upon completion of job? • Follow correct procedures? • Use water and detergent? • Use protective clothing? • Use hose, nozzle, and wash guns? • Use various cleaners to demonstrate proper method of cleaning airfoil surface of oil, dust, or dirt?
Safety protection to openings in the airplane structure.	• Check to ensure that the procedure would not damage the airplane?

IDENTIFY CORROSION.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  Sample corroded aluminum parts.

- **Performance:**
  The student will select those parts which indicate intergranular corrosion. He will describe two methods of preventing and/or controlling this type of corrosion.

- **Standard:**
  The student will identify at least 80 percent of the samples showing corrosion.

Key Points	*Feedback*
Intergranular and intercrystalline corrosion.	• How does intergranular corrosion differ from surface corrosion? • How is corrosion identified? • What is "exfoliation"? • What procedure could be initiated to correct the condition once it has been identified?
Control of intergranular corrosion.	• List and discuss the two causes of intergranular corrosion: a. Faulty manufacture. b. Faulty heat treatment.

Activities	*Check Items* Did the student:
Identify intergranular corrosion in the samples.	• Correctly use detection tools?
Demonstrate the various types of intergranular corrosion detection devices: a. Dye penetrant. b. Eddy current instrument. c. Sharp pointed instrument. d. Ultrasonic equipment.	• Describe the corrective action necessary?

REMOVE CORROSION.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
  Corroded aluminum parts, appropriate cleaning agents, equipment, and facilities. Reference information.

- **Performance:**
  The student will remove corrosion products, such as metal flakes, scale, powder and salt deposits from aluminum parts. He will describe how parts are protected from dissimilar metal corrosion.

- **Standard:**
  Removal of corrosion products shall not involve unnecessary removal of solid metal. Description of corrosion protection methods shall be in accordance with specific reference information.

Key Points	*Feedback*
Removal of flakes, powder and salt deposits, and scale.	**• Describe the means by which surface corrosion can be removed:** **a. By hand.** **b. By mechanical means.** **• What precautions must be taken on cladded surfaces?** **• When using a standard solution of 10% chromic acid to approximately 20 drops of battery electrolyte, why is time an important element?** **• When inspecting, how can it be determined that all corrosion has been removed?** **• What is the problem if all corrosion is not removed?**
Protecting aluminum alloy parts against corrosion.	**• What is surface corrosion?** **• How can it be prevented?** **• Describe two chemical and electrical chemical processes for anodically treating aluminum.** **• What is cladding?** **• What are tradenames for clad materials used by:** **a. Aluminum Co. of America.** **b. Reynolds.** **c. Kaiser.** **• Name five organic coatings used to protect aluminum.**
Dissimilar metal corrosion.	**• What is electrolytic action?** **• How can it be prevented?** **• What is a galvanic chart?** **• List at least five insulating materials which may be used to reduce or eliminate dissimilar metal corrosion.**

Activities	*Check Items*
	Did the student:
Remove scale, flakes and corrosion deposits from corroded aluminum.	**• Identify aluminum samples with different types of corrosion?** **• Use protective clothing?** **• Select corrosion removal materials?** **• Read MIL specifications to verify results of demonstration and observe safety procedure in handling acids?**

APPLY PROTECTIVE COATINGS.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  Typical aircraft component parts, protective paints and organic coatings.
- **Performance:**
  The student will apply paints and/or similar organic coating to aircraft parts. He will clean and protect battery compartments and adjacent areas by neutralizing the acid, removing corrosion, and applying acid-proof paints. He will identify "fretting" corrosion.
- **Standard:**
  Resultant finishes will be of return-to-service standard. When shown sample parts, the student will be able to distinguish between chemically induced and "fretting corrosion."

Key Points	*Feedback*
Paints and organic coatings.	**• How do paint and organic coatings serve to protect surfaces from corrosion?** **• Name several paints and organic coatings widely used for corrosion control on aircraft?** **• Where would each of the products named be used?** **• What is a prerequisite to the application of most paints and organic coatings?** **• Describe where each of the following methods of application would be used:** **a. Dip.** **b. Wipe.** **c. Spray.** **d. Brush.**
Cleaning and protecting battery compartments and adjacent areas.	**• What is an electrolyte and how does it react when spilled on metal? How can it be neutralized?** **• Describe the procedures for cleaning a surface on which electrolyte has been spilled.** **• Name several coatings that might be used.** **• Describe the methods of securing a battery to prevent spillage.**

	•Explain why battery boxes are vented. •Why do some airplanes have a battery sump in a ventilating system? •What procedures apply to cleaning of nickel cadmium battery boxes?
Cause and corrective procedures for fretting corrosion.	•What is fretting? •How would you obtain maximum protection in areas where fretting occurs? •What is another term for fretting?

Activities	*Check Items* Did the student:
Remove and neutralize corrosion.	•Identify acid-proof paint? •Identify acid neutralizing agents? •Observe safety precautions? •Display knowledge of cause by inspecting most likely areas? •Correctly use tools? •Observe safety precautions?

REMOVE RUST.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  Steel aircraft parts, rust inhibiting materials and suitable equipment for removing rust.

- **Performance:**
  The student will remove rust from ferrous aircraft parts and apply rust inhibiting finishes. He will describe the methods of protecting the interior of steel tubing and demonstrate the use of blast cleaning methods.

- **Standard:**
  The finished parts shall be of return-to-service quality.

Key Points	*Feedback*
Removal of rust.	•Define rust. •Discuss the merits and limitations of the following methods of removing rust: a. Scrapers. b. Abrasives. c. Pickling agents.
Prevention of rust.	•List ten means by which a surface may be kept dry and thus prevent rusting. •Discuss the relative merits of each.
Treatment of interior surfaces of metal tubing.	•Name three accepted materials used to prevent rust and corrosion in closed tubular members. •How may a protective finish be applied to the inside of tubing? •What is the minimum temperature for application of the protective material? •How are openings sealed after application of the coating?
Blast cleaning of corrosion resistant parts.	•What is blast cleaning? •Can it be used indiscriminately as a means of cleaning? •What are the different blasting materials used in the cleaning process? •What can be done to avoid plugging internal passages when blasting?

Activities	*Check Items* Did the student:
Remove rust from parts.	•Demonstrate knowledge of procedure?
Apply an acceptable protective finish.	•Display good safety habits?

CLEAN RUBBER PRODUCTS.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- **Given:**
  Sample aircraft rubber products (tires, tubes, boots, etc.).

- **Performance:**
  From sample rubber products that show the deteriorating effects of various cleaning materials, acids, caustics, hydrocarbons, sunlight, heat, etc. the student will describe the probable cause. He will demonstrate acceptable methods of removing oil, hydraulic fluid, battery acid, solvents and caustics from tires.

- **Standard:**
  Provided with ten samples displaying evidence of deterioration, the student will identify the probable cause in 70% of the sample cases. Cleaning of tires will be accomplished without further damage to the tire.

Key Points	*Feedback*
Protection of rubber products.	**•Describe several ways of protecting rubber surfaces from the harmful effects of cleaning agents.** **•Describe corrective procedures to be followed when the following materials are spilled on rubber products:** **a. Oil.** **b. Hydraulic fluid.** **c. Battery acid.** **d. Solvents.** **e. Caustics.** **•How does sunlight affect rubber products?** **•How does heat affect the storage of rubber products?**

Activities	*Check Items* **Did the student:**
Select samples and judge probable cause of deterioration. **Clean a tire to minimize deterioration due to oil, hydraulic fluid, etc.**	**•Observe safety precautions?** **•Follow correct procedures?**

GROUND OPERATION AND SERVICING

26. IDENTIFY AND SELECT FUELS. (EIT = 4 hrs., T = 2½ hrs., L/S = 1½ hrs.) 1 segment

(UNIT LEVEL 2)

IDENTIFY AIRCRAFT FUELS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Aircraft operator's manual, a list of colors and octane rating ranges and a fuel system of an airplane.
- **Performance:**
  The student will obtain fuel samples from the fuel system of an airplane and verify that the fuel at least equals the minimum required octane rating. He will associate each color with the correct octane range, and describe how volatility is related to vapor lock, and will discuss the advantages and limitations of kerosene as a turbine fuel.
- **Standard:**
  Matching of color to octane rating will be 100 percent correct.

Key Points	*Feedback*
Significance of octane/performance number in identification of fuel.	•What is iso-octane? •What is normal heptane? •How do these produce the octane number? •Why are performance numbers used when a fuel exceeds 100 octane rating? •What is the significance of the second number in fuel rating, i.e., 100/130? •What happens if the octane rating is: a. Too low? b. Too high? •Which is more critical? •How is the minimum octane rating of fuel for each engine installation determined?
Color identifying octane rating or performance number.	•What colors are used in identification of fuels? •Do they adversely affect combustion? •How do colors aid in detecting leaks?
Vapor lock on a reciprocating (piston) engine.	•What is vapor lock? •Where is it most likely to occur?
Cause of detonation and effective elimination.	•List various factors that contribute to detonation. •What is the difference between detonation and preignition? •What is the effect of adding tetraethyl lead to gasoline? •Why is gasoline-soluble bromine compound added to the lead? •What is the standard method of expressing lead concentration in gasoline? •List the differences between aircraft and automobile fuels.
Kerosene vs. gasoline as fuels for turbine engines.	•In the choosing of fuels, how do kerosene and gasoline compare as to: a. Weight/unit volume? b. Heat/unit volume? c. Evaporation? d. Volatility? e. Viscosity? f. Ease of starting? g. Lubrication of pumps? h. Flameout characteristics? i. Explosive qualities? •How have commercial users developed their JP fuels? •What are the advantages of: a. JP-1? b. JP-2? c. JP-3?

Activities	*Check Items*
	Did the student:
Obtain fuel samples.	•Select manuals for the specific aircraft? •Investigate the different sources for the fuel identification? •Interpret fuel tank placard (gallons and octane number on the cap)?
Identify octane ratings of fuel.	•From a collection of fuel samples, choose a specified fuel by fuel color? •Show awareness of explosion hazards? •Use fire bottle?

27. START, GROUND OPERATE, MOVE, SERVICE AND SECURE AIRCRAFT. (EIT = 26 hrs., T = 8 hrs., L/S = 18 hrs.) 6 segments

(UNIT LEVEL 2)

USE FUELING EQUIPMENT

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Fueling equipment, airplane fuel tanks nearly empty, a specified fuel load, and an airplane fueling procedures manual with fuel charts.

- **Performance:**
  The student will perform fueling of the airplane to bring the total fuel in the tanks up to the specified load, with distribution between tanks as specified in the fueling manual.

- **Standard:**
  Total fuel load and amount in each tank will be within 10 percent of the amounts specified in the fuel charts and fueling will be accomplished in accordance with specified procedures without error.

Key Points	*Feedback*
Method of refueling.	•What are the problems of fueling aircraft from: a. Cans? b. Truck? c. Underground storage system?
Operation.	•How is required octane determined?
a. Distribution of fuel.	•How is the proper fuel distribution for the specified load determined?
b. Measurement.	•How would a mechanic determine the quantity of fuel in the tanks prior to fueling? •How would a mechanic determine the amount of fuel to be added?
Precautions.	•What precautions must be observed when removing cap? •What precautions must be taken before inserting nozzle in tank? •What precautions should be taken when fueling in: a. Rain? b. Snow? c. Dust? •What precautionary steps are required when fueling from cans?
Safety.	•How is spillage handled? •In fueling, why must a ground cable be attached to the aircraft and fuel truck, if used?

Activities	*Check Items* Did the student:
Add fuel to an airplane.	•Use aircraft fueling procedure manual? •Determine distribution for required fuel load? •Make sure proper kind of fuel is selected?
Select the correct octane and kind of fuel.	•Make sure the fuel selected is of proper octane or performance number?
Measure fuel already in each tank of the aircraft.	•Dip-stick each tank and interpret quantity correctly?
Measure fuel added.	•Make sure proper amount of fuel is in each tank when fueling is completed?
Observe proper fueling precautions.	•Ground airplane and truck? (if used) •Use proper precautions during fueling?
Inspection.	•Avoid spillage of fuel? •Inspect the securing of the fuel cap?

START AND OPERATE AIRCRAFT ENGINES.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Aircraft engines equipped with float type carburetors, pressure injection carburetors, and internal superchargers. Written engine operating procedures for each given type of engine, and auxiliary power requirements, and operating specifications.

- **Performance:**
  The student will perform two starts with each type of engine, operate each type through its normal operating range and perform complete shut down for each type. He will select, connect, and operate an adequate external auxiliary electrical power source.

- **Standard:**
  All starts, operation, and shut-downs will comply with given procedures without error and auxiliary power will be selected, connected and operated as specified.

Key Points	*Feedback*
Starting procedures for 4–cycle reciprocating piston-type engine.	•Why is the propeller "pulled through"?
	•Why might the master switch be turned on prior to starting an engine?
	•Why may the procedures specify different ignition switch positions for starting different engines?
	•Why is prime often used before cranking the engine?
	•What is the result of overpriming?
	•What is the position of the mixture control when starting?
	•What is a warm-up procedure?
	•What is a magneto check?
	•What is the carburetor heat position for starting?
	•What are the vital engine instruments used for starting?
	•List a standard starting procedure for an engine with a float type carburetor.
	•How would the above procedure vary with a pressure injection carburetor?
	•How would the above procedure vary with an internal super-charged engine?
Safety precautions.	•What is the need for someone to man a fire bottle when starting an engine?
	•Why are wheels chocked before starting an engine?
	•What information will a pilot usually request before pressing the starter switch?
	•List the fire hazards involved in starting an engine.
Types of external auxiliary electrical power sources.	•What factors are involved in the selection of an auxiliary power source?
a. Battery cart.	•What considerations must be taken as to voltage, ampere-hour capacity and state of charge of the battery cart?
b. Motor generator or rectifier power unit.	•What are the limitations to power units operated from electrical outlets?
	•Why is this type of power unit best suited for extended time operations?
c. Gasoline driven auxiliary power unit.	•What factors should be checked to assure that the power unit is compatible with the aircraft?
Connecting external power for use by an airplane.	•What precautions should be taken before plugging any power source into the airplane?
	•How should the cockpit power switch be set?
	•How should the switch on the power unit be set?
Power unit operation.	•List the procedures for starting and operating each type of power unit.
Prerequisites for starting piston engines.	•What are the manuals which are appropriate for the starting of engines?
	•Why should the starting mechanic review the starting and operating procedures prior to taking any action?
Prestarting procedures.	•What are the starting mechanic's responsibilities for a fire guard and availability of fire bottles?
	•Why should he make a dry run through the starting procedures?
	•What information is needed with reference to the specific type of carburetor in use?
Starting procedures.	•How is the sequence of starting determined?
	•Describe the precautions in starting and operating engines when in unusual weather or surroundings.
Operating procedures.	•What considerations should influence the type and length of operation after the engine is started?
	•What indications and controls require careful attention throughout the operation of the engine?
Shut-down procedures.	•How important is it that the proper shut-down procedures are followed?
	•What are some dangers to the engine from improper shut-down procedures?
Safety and inspection.	•What is the responsibility of the mechanic regarding any unsafe actions or violations of rules during his period of engine operation?

	•What inspection should be made after an engine has been run for a period of time?

Activities	*Check Items*
	Did the student:
Prepare for engine starts.	•Obtain applicable engine procedures and review them? •Make a dry run before turning on any power? •Check that a fire guard is ready before making any start?
Select and connect external auxiliary power unit.	•Make sure power unit was of proper voltage and had adequate power? •Connect power unit with power off, then start the unit, turn on power, and set controls properly?
Start engine.	•Check procedure applicable to type of carburetor involved? •Observe safety procedures during starting?
Operate engine through its power range.	•Follow procedures during all steps of the operation?
Shut-down engine.	•Follow proper steps and sequence during shut-down?
Observe safety precautions and make inspection following shut-down.	•Adhere to proper safety precautions? •Look for any indications of malfunction or improper operation? •Make sure all cowling and accessories are in airworthy condition.

REACT TO FIRE IN AN INDUCTION SYSTEM.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  CO^2 fire extinguisher equipment and written information on fire extinguishment.

- Performance:
  The student will operate a fire extinguisher to properly extinguish burning fuel in an open pit or container and take proper fire fighting action for a simulated aircraft induction system fire.

- Standard:
  Handling and operation of fire extinguisher in accordance with procedures provided. CO^2 will be properly directed into induction system from start at fire guard position within five seconds.

Key Points	*Feedback*
Types of extinguishers.	•What types of extinguishers are available? •Which is the best type for induction fires? •Describe the operation of each type of extinguisher.
Extinguishing procedure.	•List the steps in sequence for extinguishing an induction fire.

Activities	*Check Items*
	Did the student:
Operate fire extinguisher to extinguish fuel fires.	•Take proper preparatory steps for using the extinguisher? •Move in on the fire in a safe and effective manner? •Quickly and effectively put out the fire?
Operate a fire extinguisher on a simulated induction system fire.	•React to call of "fire" by pointing extinguisher into induction system promptly? •Check condition of fire situation for further action?
Inspect after fire is out.	

CONNECT AND OPERATE AN EXTERNAL HYDRAULIC POWER SOURCE.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  An aircraft or hydraulic system mock-up with normal hydraulic operating pressure specified, an external hydraulic power source, and written operating instructions.

- Performance:
  The student will connect the external hydraulic power source to the aircraft or mock-up and operate the external source to obtain specified hydraulic pressure in the aircraft or mock-up hydraulic system.

- Standard:
  Connections and operation will conform to the written instructions and specified pressure will be maintained in the aircraft or mock-up during system operation from the external power source.

Key Points	*Feedback*
Power units.	•List different types of hydraulic power units available for system checks:

	a. Portable. b. Fixed.
Compatibility.	• How are fluids of the system checked for being compatible with those of the power unit?
Connection to system.	• What would be required to connect an auxiliary source of hydraulic power into an airplane hydraulic system? • What is the difference between a pressure and a scavenge line and what effect would it have if they were reversed when hooked into a system? • How is spillage taken care of when connecting and disconnecting an external hydraulic power source?
Operational checks.	• How is system pressure determined? • What is meant by isolating a sub-system and how is it accomplished?
System replenishing.	• How can the external power source be used to replenish the airplane hydraulic supply?

Activities	*Check Items*
	Did the student:
Determine compatibility of hydraulic power source to airplane system.	• Check for compatibility of fluids? • Indicate knowledge of hydraulic power unit operation?
Connect power source to the airplane system.	• Follow the service manual?
Use tools and manuals to connect power source to airplane hydraulic system.	• Use proper connecting tools? • Avoid fluid contamination? • Locate drip pans? • Locate the airplane hydraulic system connections? • Bleed off any pressure in system?
Operate power source and airplane system.	• Connect lines in proper sequence? • Operate the system in accordance with operating instructions? • Isolate a sub-system as directed?
Practice safety.	• Make sure fire bottle is available? • Check for any leaks?
Inspect connections.	• Check to verify proper connection in order to prevent damage to the aircraft and the unit.

DIRECT THE MOVEMENT OF AIRCRAFT.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:
  Hand signal charts or instructions, live or simulated aircraft movements.

- Performance:
  The student will use accepted hand signals in providing directions to the movement of aircraft during towing, taxiing, and parking.

- Standard:
  Signals must be sharp, clear and in conformance to instructions. Response to changing conditions must be instantaneous.

Key Points	*Feedback*
Hand signals for communications.	• What basic information can be communicated by hand signals? • What auxiliary devices can be used for ground operation communications?
Towing procedures.	• Should the signals be directed to the tow man or the brake rider? • Who is responsible for the final positioning of a towed airplane?
Taxi and parking procedures.	• How will the taximan know who is the signalman? • How is a safe "follow me" guidance procedure performed? • What should you consider when parking an aircraft — a vehicle?

Activities	*Check Items*
	Did the student:
Provide taxi and towing signals.	• Exhibit knowledge of hand signals? • Select proper signal equipment?
Provide signals for parking.	• Give parking signals to park an airplane and a vehicle? • Demonstrate the signals to stop and park an aircraft?
Provide signals for directing traffic.	• Demonstrate directing traffic by hand signals? • Observe traffic movement?

Practice safety in use of signals and directing traffic.	• List violations of approved procedures in directing traffic?

PREPARE AN AIRCRAFT FOR OUTSIDE STORAGE.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  Aircraft for outside storage, written storage procedures, and necessary securing equipment.
- Performance:
  The student will prepare an aircraft for outside storage. He will analyze requirements and secure the aircraft for normal weather conditions at that location.
- Standard:
  Aircraft will be tied down and secured to prevent damage under normal weather conditions.

Key Points	*Feedback*
Equipment used for securing aircraft.	• What are chocks? • What are: 1) portable tiedowns? 2) stationary tiedowns? • Where are the tiedowns attached to the aircraft? • Name guidelines in the selection of rope for tiedowns.
Procedures for securing aircraft.	• How is an aircraft positioned with regard to prevailing wind? • Why are controls locked? • Why is the master switch pulled? • What precautions should be taken concerning locking brakes? • Why should cabin doors and windows be closed and locked?
Protection against weather.	• When may it be wise to install spoilers on wing and empennage? • Why is it advisable to set or install gust locks? • What concern should be given to propeller position? • When are wheel chocks needed?

• Is all work performed to prevent damage under normal weather conditions?

Activities	*Check Items* Did the student:
Tiedown an aircraft for outside storage.	• Use proper tiedown methods? • Collect the necessary equipment for securing the aircraft? • Attach the securing devices to the aircraft?
Secure the airplane against wind gusts.	• Lock the aircraft controls and parking brakes as needed?
Secure cockpit controls and cabin exits.	• Turn off switches? • Lock the cabin door and windows? • Chock the wheels?
Recheck and inspect to assure preparations are complete.	• Re-check the securing procedure and anchors? • Lock all the controls? • Position the aircraft correctly with regard to prevailing wind?

28. SELECT AND USE FAA AND MANUFACTURER'S AIRCRAFT MAINTENANCE SPECIFICATIONS, DATA SHEETS, MANUALS, AND PUBLICATIONS, AND RELATED FEDERAL AVIATION REGULATIONS. (EIT = 13 hrs., T = 6½ hrs., L/S = 6½ hrs.) 7 segments

(UNIT LEVEL 3)

LOCATE REFERENCE DATA.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  An index and sample random copies of the FAA Aircraft Specification Sheets and listing.
- **Performance:**
  When provided with the manufacturer's name, model and serial number, the student will locate the specification sheets for five airplanes.
- **Standard:**
  The student will locate the specification sheets promptly and without error.

Key Points	*Feedback*
FAA specifications and Type Certificate Data Sheets.	•What is the purpose of a Type Certificate Data Sheet? •How is a specification originated? •What information is contained in a Type Certificate Data Sheet? •What data is available for airplanes that are built in limited production? •How does the aircraft specification differ when information is found in the listing? •What conditions must exist before an aircraft is transferred to the listing?

Activities	*Check Items* Did the student:
Locate, select and identify FAA Type Certificate Data Sheets for five specifically identified aircraft.	•Promptly locate the Data Sheets? •Use correct nomenclature when referencing these publications?

USE INFORMATION FROM THE AIRCRAFT SPECIFICATIONS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  An indexed sample file of Aircraft Specifications and associated manufacturer's service manuals.
- **Performance:**
  The student will locate and interpret information pertaining to weighing, useful load, center of gravity range, and approved items of equipment for two specifically identified makes and models of aircraft.
- **Standard:**
  The student will locate and interpret information without error.

Key Points	*Feedback*
Identifying aircraft specifications.	•Why can't manufacturers' trade names be used to locate information in the aircraft specifications? •If the basic model number is known, what is the importance of a letter which may appear as a suffix in the model designation? •What is the significance of a letter appearing as a prefix to the basic model number? •What is the value of a serial number when identifying information in the aircraft specifications?
Weighing information.	•What is a datum? •What are some commonly used datum line locations? •If leveling points are not provided, how is the means of leveling specified? •How is gross weight defined? •Why is information about seat location important to a mechanic? •How does aircraft category (normal, standard, utility, etc.) effect seat locations?

	• When seats are mounted on tracks and may have alternate positions, how is the seat position indicated?
CG ranges.	• What is the significance of an empty weight center of gravity range? • If an empty weight CG range is not specified, what is significant? • Why are CG ranges different when the airplane may be certificated in different categories? (i.e., standard/utility, etc.) • Why are the specified CG ranges not applicable to airplanes that do not comply with the original ATC?
Items of equipment.	• How do the specification sheets distinguish between required and optional items of equipment? • How can a mechanic determine the make and model of engine and propeller approved for use on a specific airplane? • What reference publications would indicate the maximum diameter of propeller authorized for installation on an airplane? • Where could information relating engine/propeller speed ratios be found?

Activities	*Check Items*
	Did the student:
Using the FAA specifications and Type Certificate Data Sheets for two specific models of aircraft: a. Identify leveling and weighing information. b. Identify the useful load and empty center of gravity range. c. Determine the location of pilot and passenger seats. d. Specify one propeller/engine combination and propeller diameter that is approved. e. Determine the engine to propeller speed ratio.	• Identify and use the correct specification for the make and model of aircraft? • Correctly interpret information from the specification or listing?

USE INFORMATION FROM THE MANUFACTURER'S MANUALS TO VERIFY CONTROL SURFACE TRAVEL.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  Any specified model of aircraft and the appropriate specification sheets and manufacturer's service manual.

- Performance:
  The student will compare the control surface travel specified in each publication. He will measure the travel of the controls on the airplane and determine whether the travel is acceptable.

- Standard:
  Interpretation of information will be without error. Measurement of travel will be within plus or minus one degree.

Key Points	*Feedback*
Control travel reference information.	• In what manner may manufacturers' service manuals offer better information than the aircraft specifications? • If the travel specified in each publication is not the same, what information should be used? • Why should the serial number of the airplane be known when referencing travel limits?
Methods of expressing limits of travel.	• What is differential control surface movement? • What reference planes are used in measuring control surface movement? • If a tolerance is expressed as +2°, – 0°, which limit is critical?

Activities	*Check Items*
	Did the student:
Locate and select the proper specifications for the aircraft.	• Accurately locate reference information?

	Interpret and compare the limits established by specifications and manufacturer's manual?
	Use correct nomenclature?
Check control surface movement against limits listed in specifications or manufacturer's manual.	Correctly establish measuring references? Correctly use tools and equipment necessary for measuring travel? Judge and determine whether the travel was acceptable?

IDENTIFY AND RELATE REGULATIONS GOVERNING AIRWORTHINESS CERTIFICATES.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  Sample copy of an airworthiness certificate and applicable Federal Air Regulations.

- Performance:
  The student will explain the purpose of an airworthiness certificate, the duration and requirements for keeping the certificate in effect.

- Standard:
  The student will use the correct references and interpret the regulations without error.

Key Points	*Feedback*
Applicability of FAR to aircraft airworthiness certificates.	Why does the A/C serial number appear on the airworthiness certificate? Is an airworthiness certificate a part of the permanent maintenance records? What specific part of the Federal Air Regulations governs the issuance of an airworthiness certificate? How is the certificate kept current?

Activities	*Check Items* Did the student:
Interpret the provisions of FAR applicable to airworthiness certificates. Interpret the information displayed on a sample airworthiness certificate.	Demonstrate his ability to locate information in the appropriate part of the Federal Air Regulations? Correctly relate and interpret the regulations?

SELECT AND USE TECHNICAL STANDARD ORDERS.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- Given:
  A random file of technical standard orders (TSO), and five sample parts that were manufactured under a TSO.

- Performance:
  The student will select the applicable TSO and interpret the information to determine whether the sample components comply.

- Standard:
  The student will correctly interpret those provisions of the TSO pertaining to identification of 4 components.

Key Points	*Feedback*
Purpose, legal status of TSO's.	What is a TSO? What purpose does a TSO serve? Under what circumstances are TSO's required? How does a TSO'd part compare with a non-TSO'd part? What legal status does a TSO possess? What is the relationship of a TSO and FAR? Why are TSO's often used in logbook references?

Activities	*Check Items* Did the student:
Locate the TSO applicable to sample component. Interpret the requirements of the TSO.	Use the index of TSO's? Correctly interpret quality standards in the TSO? Recognize systems of marking or identifying TSO's Describe the quality assurance spelled out in TSO?

USE MANUFACTURERS' MANUALS AND OTHER PUBLICATIONS.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- **Given:**
  A selection of manufacturers' maintenance/service/overhaul/operating publications, a display of instruments, and typical oversize and undersize airframe and powerplant components.

- **Performance:**
  The student will refer to the appropriate manual. He will interpret the information as a prelude to inspecting the range marking of instruments and identify the displayed oversize and undersize parts.

- **Standard:**
  The student will locate information in the reference publications without omission or error.

Key Points	*Feedback*
Range marking of instruments.	• Where are the operating limits applicable to a specific airplane published? • Describe the procedure used when applying decals as a method of range marking instruments. • How would paint be applied as range marks? • Is parallax error considered when range marking the instruments? • How many colors generally appear in the range marking of: a. Airspeed indicators? b. Tachometers? c. Oil temperature and pressure gauges? • What is the purpose of a slippage mark?
Identification of oversize and undersize parts.	• What four relationships are involved with over and undersized parts? • Why is the "Table of Limits" important to a mechanic? • Is a part that is within the "Table of Limits" airworthy? • What is the difference between a "factory-new" and a "service" limit? • What physical/visual features identify oversize and undersize parts?

Activities	*Check Items*
	Did the student:
Inspect the range marks of instruments in a given aircraft and check them with respect to the A/C specifications or Operators manual.	• Check instrument glass to ensure against rotation? • Locate references and correctly interpret information?
Identify oversize and undersize parts by interpreting manufacturer's manual.	• Use the correct reference table? • Identify both over and undersized parts?

SELECT AND USE SUPPLEMENTARY TYPE CERTIFICATES AND AIRWORTHINESS DIRECTIVES.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- **Given:**
  A reference summary file of airworthiness directives and supplementary type certificate listing.

- **Performance:**
  The student will write a correct and complete list of all AD's applicable to a specified make and model aircraft.

- **Standard:**
  The listing will be without error.

Key Points	*Feedback*
Airworthiness directives.	• Why are AD's often limited to airplanes within a particular serial number range? • Who issues an AD? • How does a manufacturer participate in the AD notification system? • Who receives copies of AD's? • What is the importance of an AD to a mechanic? • How do service letters effect AD's?
Supplementary type certificates. (STC)	• What is the purpose of an STC? • Who may apply for an STC? • In what manner may an "AD" apply to an airplane modified to comply with an "STC"?

Activities	*Check Items*
	Did the student:

List airworthiness directives applicable to a specified make, model and serial numbered airplane.	•List all applicable AD's? •Avoid listing AD's that did not apply by reason of serial number?

29. READ TECHNICAL DATA (EIT = 6 hr., T = 3 hr., L/S = 3 hr.) 1 segment

(UNIT LEVEL 3)

READ, UNDERSTAND AND RELATE TECHNICAL INFORMATION.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  A file of technical reference information (manufacturers' reports, bulletins, service letters, inspection aids, etc.).

- Performance:
  The student will interpret and apply this information as a method of solving two maintenance problems described by the instructor.

- Standard:
  The student will locate applicable technical data within reasonable time limits. Interpretation of information will be without error.

Key Points	*Feedback*
Kinds of technical reports and publications.	•What are some of the sources of technical reports? •How do service bulletins or service letters originate? •Where would a mechanic find drawings illustrating the specifications of an AN or NAS bolt? •Where would the specifications of lubricants be published? •Why do some service directives require immediate compliance while others may be deferred?

Activities	*Check Items* Did the student:
Research two assigned topics and list specific references and sources of information.	•Make a thorough search and provide a complete list of references?
Write a description of work which would be done to comply with a manufacturer's service directive.	•Develop a logical sequence of operations? •Indicate that an appropriate entry would be made in the aircraft records?

MECHANIC PRIVILEGES AND LIMITATIONS

30. EXERCISE MECHANIC PRIVILEGES WITHIN THE LIMITATIONS PRESCRIBED BY FAR 65.

(EIT = 5 hrs., T = 2 hrs., L/S = 3 hrs.)
5 segments

(UNIT LEVEL 3)

INTERPRET FAR 65.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  FAR 65.

- Performance:
  The student will read and interpret the regulations governing issuance, duration, experience, and limitations of mechanic certificates and an inspection authorization. He will answer a ten question multiple choice examination, based on FAR 65.

- Standard:
  The student will answer eight questions correctly.

Key Points	*Feedback*
FAR part 65.	•Explain the requirements an applicant must meet for issuance of a mechanic certificate. a. The minimum age requirement for issuance of a mechanic certificate. b. The requirements for reporting change of address. c. The duration or effective period of a mechanic certificate issued to a U.S. citizen. d. The recency-of-experience requirements for certificated mechanics. •What are the mechanics privileges and limitations with regard to returning an aircraft to service following major repairs? •What limitations apply to a mechanic in the conduct of 100 hour and annual inspections?
Inspection authorization.	•For what period of time must a mechanic hold his certificate before becoming eligible for an Inspection Authorization? •What are the regulations regarding a local base of operations for an IA? •What facilities, tools and equipment are necessary to an IA when he conducts annual inspections? •What are the procedures and requirements for issuance of an Inspection Authorization? •What are the renewal requirements for an IA?

CLASSIFY AIRCRAFT REPAIRS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  FAR part 43 and the associated advisory circulars and maintenance forms.

- Performance:
  The student will apply and interpret Federal Air Regulations Part 43 as a means of classifying major repairs, minor repairs, major and minor alterations and routine (preventative) maintenance, and make simulated maintenance record entries.

- Standard:
  Interpretation of Federal Air Regulations will be without error. Simulated maintenance record entries shall comply with Federal Air Regulations.

Key Points	*Feedback*
FAR part 43.	•Describe the circumstances under which an aircraft may be operated if it has not had an annual inspection within the preceding 12 months. •What repair classification is given to the replacement of aircraft components with new, rebuilt, or repaired components of similar design?

- Describe the procedure that would permit the return-to-service of an airplane with an engine of a type other than that with which the aircraft was originally certificated?
- How is the servicing of landing gear shock struts classified in terms of the type of repair?
- How is the removal, repair and installation of tires classified?
- Identify the repair classification assigned to the replacement of fabric on wings, fuselages, control surfaces, etc.
- What criteria determines the classification of repairs made to propellers?
- What specific items distinguish between major and minor power-plant repairs?

Activities	*Check Items*
	Did the student:
Make typical maintenance record entries describing five major or minor repairs.	• Adequately describe the repair and/or alteration? • Correctly identify the aircraft being repaired/altered? • Sign the form? • Date the entry? • Record the time on the aircraft?

INTERPRET REGULATIONS GOVERNING REPAIRS AND ALTERATIONS.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  Reference file of Federal Air Regulations and advisory circulars and samples of aircraft maintenance records.

- Performance:
  The student will describe the procedure to be followed and then submit the necessary forms and substantiating data to permit approval of a major repair and a major alteration of an airplane or powerplant or propeller.

- Standard:
  The procedure described and the data submitted will be without error.

Key Points	*Feedback*
Applicable Federal Air Regulations. a. Major alterations.	• What reference should be used to determine the types of engines approved for installation in an airplane? • If an alternate engine installation has been approved: a. What forms must be submitted prior to returning an altered airplane to service? • If a proposed engine installation has never been approved, what procedure should be followed? • What engineering data and authority is generally considered necessary when installing engines of a different type and power rating? • What limitations are applicable to mechanics and authorized inspectors when major alterations are accomplished?
b. Propeller repairs and alterations.	• Describe some propeller repairs that would be classified as: a. Major repairs. b. Minor repairs. c. Routine or preventative maintenance. • What limitations are imposed with regard to propeller repairs? • If the propeller manufacturer permits conversion of a propeller from one model to another, what repair agency may accomplish this work? • If a propeller of an approved type is installed on an airplane, who may sign the aircraft records approving the installation?
Modification of structures.	• If welded repairs are made to a steel tube structure without changing the basic structure, how is this repair classified?

- If structural work has an appreciable effect on the strength, weight or integrity of a steel tube structure, or flight characteristics, how is this work classified?
- If the proposed modification of a structure involves replacement of fabric covering with metal, what is the classification of work?

Activities	*Check Items* Did the student:
Use Federal Air Regulations to classify repairs, alterations and modifications.	• Refer to type certificates and supplementary type certificate information? • Locate reference information promptly and interpret information accurately?
Review samples of aircraft maintenance records.	• Detect aircraft record files which were incomplete (i.e., not signed, not dated)?
Describe procedure and submit data for: a. Major repair. b. Major alteration.	• Use correct nomenclature and submit concise, accurate data?

INTERPRET REPAIR STATION REGULATIONS.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- Given:
  FAR, part 145 and sample copies of repair orders, work/time sheets, inventory and parts control records, etc.

- Performance:
  The student will interpret the regulations pertaining to the economics, organization and management of an aircraft repair shop. He will answer a twenty question quiz based on typical shop management problems.

- Standard:
  The student will correctly answer 14 of the 20 questions.

Key Points	*Feedback*
FAA regulations regarding repair station operation (FAR 145).	• As a repair station is approved on the basis of certain facilities, equipment and personnel, what happens if the station is moved to a different location – or has changes in personnel? • Why are complete records of all work performed so vital to the operation of an approved repair station? • Why do parts department personnel insist that mechanics "sign-for" parts at the time they are issued? • Why should mechanics insist that persons in a parts department "sign-for" returned parts? • If an incorrect or defective part is issued from the parts department, and installed by a mechanic, who is responsible? • Under what circumstances could an engine be overhauled by a mechanic working in a repair station which held only an airframe rating? • Who is responsible for the work performed? • Why should a mechanic check the "shelf-life" or storage date on perishable parts? Give five examples of perishable parts. • What is a mechanic's responsibility if he uses a precision measuring or testing device that is beyond its required calibration date? • Why is an elementary knowledge of accounting desirable when the shop is "closing" a customer repair order? • If a customer objects to the repair charges and refuses payment, what recourse is available to the shop and/or the mechanic?

RECOGNIZE LEGAL AND ETHICAL RESPONSIBILITIES.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- Given:
  A description of ten circumstances or conditions relating to legal or ethical practices of the trade.

- Performance:
  The student will judge each circumstance and indicate his decision.

- Standard:
  In a multiple choice test, the student will judge ten hypothetical cases and react in a manner that is both legal and generally accepted as "standard practice" within the industry. He will correctly judge 7 of the ten cases.

Key Points	*Feedback*
Bailment. Mechanics liens.	•What legal responsibility exists when payment is accepted for "storage" or "tiedown" of an airplane?
Customer relationship.	•If wind damage is done to an airplane while it is parked on a service ramp, who is responsible? •Why is it important that a customer sign a repair order authorizing work on his airplane? •If a part that has been installed on an airplane fails, what legal responsibilities exist? •If the repair procedure used in accomplishing a repair is not in accord with published instructions, what legal and moral responsibility may exist? •If, in the course of correcting a defect, parts which were not specifically authorized by the customer are installed, is this repair bill collectable? •A mechanic promises that repairs will be accomplished and finished at a specified time and he cannot meet the completion time, is there any legal responsibility? •If a written estimate of repair costs is provided and the final charge exceeds the estimate, is the repair charge collectable? •Why do written estimates for repairs usually include a charge excluding "hidden damage"? •Why do written estimates for repairs usually contain a specified time limit?
Pride and craftsmanship.	•If an inspection disclosed substandard work which had been performed by some other repair agency, what action would be taken? •If a mechanic is asked to approve or "sign-off" work which he feels is not airworthy, what recourse does he have? •If a mechanic has personal knowledge that sub-standard work is being performed in the shop, how should he react? •If a mechanic knows that other mechanics in the shop are falsifying time and other shop records, how should he react? •If a mechanic is aware that a safety hazard exists, what action should he take?
Integrity.	•If a mechanic is called to testify in an FAA inquiry, what testimony should he offer? •If a mechanic is testifying in a Civil Court action and he does not have any written records of the incident being questioned, what part of his testimony may be admitted as evidence? •If an unlicensed mechanic working under the direct supervision of a licensed mechanic performs substandard work, who is responsible?
Employer relationships.	•If a mechanic fails to report an injury which occurred during the performance of his work, who is responsible? •What recourse is available to a mechanic when he is aware that the employer is violating labor laws? •If repairs accomplished by a mechanic result in failure of the powerplant or airplane, what action may be taken against the mechanic?

Personal conduct.	• If maintenance work is performed in accordance with the recommendations of a maintenance manual, does this waive further personal responsibility if there is a failure of the part? • If an associate mechanic continually asks another mechanic to "sign-off" the work he performs, how should he react?

7

MAINTENANCE FORMS AND RECORDS

31. WRITE DESCRIPTIONS OF AIRCRAFT CONDITION AND WORK PERFORMED. (EIT = 5 hrs., T = 2 hrs., L/S = 3 hrs.) 2 segments

(UNIT LEVEL 3)

INSPECT AN AIRCRAFT AND PREPARE A CONDITION REPORT.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  An airplane, the manufacturer's service manual or General Aviation Inspection Aids, and a typical aircraft condition report form.

- Performance:
  The student will conduct an inspection of the airplane that will reveal the status of that particular airplane with regard to a specific service problem. He will prepare the condition report to indicate the results of the inspection.

- Standard:
  The completed report will be clear, concise and sufficiently detailed so that it reflects the status and condition of the airplane at the time of the inspection.

Key Points	*Feedback*
Manufacturer's service information.	•How does a mechanic determine whether service information applies to all aircraft or only to a few airplanes? •If a Service Directive is mandatory, what is the effect of this information on the airworthiness of the airplane? •How does a mechanic determine whether a service bulletin has been complied with?
Aircraft condition reports.	•How does a mechanic notify the manufacturer that the recommended service work has been accomplished? •How do manufacturer's alert owners and mechanics to service problems that are being encountered? •In what manner does the FAA alert owners and operators to probable service and maintenance deficiencies?

Activities	*Check Items*
	Did the student:
Inspect an airplane powerplant or propeller to determine compliance with a service bulletin. Write a condition report.	•Select appropriate guide? •Conduct the inspection in an approved manner? •Verify that the service bulletin applied to the specific make model and serial range? •Write a concise legible report, using correct nomenclature and terminology? •Correctly describe the disposition and distribution of the report?

WRITE A DESCRIPTION OF MAJOR/MINOR REPAIRS AND ROUTINE MAINTENANCE.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  The manufacturer's service manual, a copy of AC 43.13–1 and written descriptions of a major repair, a minor repair and a preventative maintenance task that had been performed on a specified airplane.

- Performance:
  The student will make entries in the aircraft maintenance records describing the work that has been accomplished.

- Standard:
  The written entries will be legible, concise, and use appropriate nomenclature and terminology. All entries will conform to the minimum requirements of the Federal Air Regulations.

Key Points	*Feedback*
Classification of repairs.	•What reference information may a mechanic use to determine the materials and repair procedures that are approved for the repair of aircraft structures? •How does a mechanic distinguish between a major and minor repair? •What penalty may be imposed upon the mechanic if he incorrectly classified a repair?

	• If the owner of an airplane insisted that preventative maintenance work be recorded in an aircraft logbook, is such an entry permitted? Is it required?
Entry requirements.	• Describe one acceptable method of indicating the location of a repair on a fuselage? On a wing? • How would a mechanic substantiate the quality of materials used to repair an airplane? • What references may a mechanic use as an authorization for repair procedure or repair practices? • What factors will assist the mechanic in determining whether drawings and sketches are necessary to the described repair?

Activities	*Check Items* Did the student:
Write an entry describing a major repair; a minor repair and a routine maintenance operation in the aircraft records.	• Organize the description of the repairs? • Make a legible entry? • Use standard references for materials and repair procedures? • Concisely locate the repair position?

32. COMPLETE REQUIRED MAINTENANCE FORMS, RECORDS, AND INSPECTION REPORTS. (EIT = 8 hrs., T = 6½ hrs., L/S = 1½ hrs.) 3 segments

(UNIT LEVEL 3)

MAKE MAINTENANCE RECORD ENTRIES.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  FAR Parts 91 and 43, AC 43.13–1 and a written description of five typical aircraft maintenance tasks.

- Performance:
  Using the appropriate references, the student will define "time in service" and explain the application of this term to entries in the maintenance records. From the written descriptions of maintenance tasks, the student will make three entries in the maintenance records.

- Standard:
  All three entries will comply with the requirements of FAR 43 and AC 43.9–1A.

Key Points	*Feedback*
Time in service – FAR 91.	• Who is responsible for entering "time in service" into the aircraft records? • What is tack time? What is engine hour-meter time? What is total time? • Describe how time is obtained from an oil pressure hour recorder. • Describe how time is obtained from landing gear actuated switches. From air-vane actuated switches? • What is the legal effect of a manufacturer's recommended overhaul period? • What liability may exist if a mechanic permits an engine to exceed the recommended "time between overhaul"?
FAR 93 and 43.	• Why must maintenance and alteration record entries be dated? • Why must the person accomplishing the repairs "sign-for" the work accomplished? • What are the requirements for a "return-to-service" entry? Why does such an entry require a signature and certificate number? • What forms are required when conducting a 100-hour inspection? Does a 100-hour inspection report become a part of the permanent maintenance records of an airplane? • Under what conditions is an ACA form 337 required?

Activities	*Check Items* Did the student:
Make a sample logbook entry.	• Comply with the minimum entry requirements? • Record the total time, date and describe the work accomplished? • Sign the entry and indicate the requirement for a certificate number?

Fill out a sample form for a major repair or alteration.	• Correctly explain the requirement for duplicate copies and the disposition of copies? • Submit a form that met the applicable Federal Air Regulations and Advisory Circulars?

USE INSPECTION GUIDES.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Typical 100– hour (annual) inspection report forms or the manufacturer's recommended inspection guide form, the Summary of Airworthiness Directives and the service manual for a specific airplane.

- Performance:
  The student will make simulated entries on the form and appropriate entries in the aircraft records to describe the inspection and the compliance with Airworthiness Directives.

- Standard:
  Simulated entries will comply with the requirements of the Federal Air Regulations.

Key Points	*Feedback*
Kinds of inspections.	• What factors determine whether an airplane must have 100–hour, annual or progressive inspections? • Who is authorized to return an airplane to service after a 100–hour inspection? Who may authorize return-to-service following an annual inspection? • What is an ACA form 2350? Who is authorized to sign this form? • Who is permitted to inspect an airplane for compliance with Airworthiness Directives? • When an airplane is "re-licensed" how soon must the form 2350 be delivered to the local FAA office?
Compliance with Airworthiness Directives.	• How do airworthiness directives originate? • What information must a mechanic have available in order to determine the applicability of an Airworthiness Directive? • Explain why some Airworthiness Directives require immediate compliance and others may be deferred. • How does a mechanic ascertain the compliance with prior Airworthiness Directives, if the parts or components cannot be inspected without major disassembly of the airplane?

Activities	*Check Items* Did the student:
Search the Airworthiness Directory Summary. Make simulated inspection entries in the aircraft records.	• List the directives applicable to a specific model and serial range of airplane? • Refer to the manufacturer's inspection procedures? • Date the inspection, record time on the aircraft, powerplant and/or component? • Sign the entry and indicate a certificate number?

EVALUATE AIRCRAFT RECORDS FOR COMPLIANCE WITH FEDERAL AIR REGULATIONS.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  A complete record file for an airplane, including Registration and Airworthiness Certificates, Operations Limitations Manual and/or placards, Radio Station License, Weight and Balance and Equipment Records, airframe and powerplant logbooks, prior Repair and Alteration records and the applicable parts of the Federal Air Regulations.

- Performance:
  The student will examine the file and judge whether it complies with the Federal Air Regulations.

- Standard:
  The student will correctly interpret and apply the regulations and judge the records without error or omission.

Key Points	*Feedback*
Required records.	**•What are the required minimum records for an airplane?** **•Who is responsible for maintaining the required file of records for an airplane?** **•What is the value of the records to each of the following persons:** **a. The original manufacturer?** **b. The prospective purchaser?** **c. The owner?** **d. The mechanic?**

Activities	*Check Items*
	Did the student:
Search an aircraft record file and judge compliance with FAR.	**•Recognize each of the required documents?** **•Use a check list to ensure that each document was available?** **•Identify inconsistencies and omissions in the documents and records?**

AIRCRAFT WEIGHT AND BALANCE

33. WEIGH AIRCRAFT. (EIT = 13 hrs., T = 4½ hrs., L/S = 8½ hrs.) 1 segment

(UNIT LEVEL 2)

LOCATE, INTERPRET AND APPLY WEIGHT AND BALANCE INFORMATION.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
Manufacturer's publications, weight and balance records for a specific airplane and the necessary weighing equipment.

- Performance:
The student will locate and interpret information necessary to the weighing of that airplane. He will describe the procedures and precautions to be observed in the weighing process, and will:

a. Position jacks, scales and level the aircraft.
b. Locate and identify all required items of equipment.
c. Make the measurements necessary to determine moment arms.
d. Read the scale weights and compute the empty center of gravity.

- Standard:
Interpretation of information, weighing of the aircraft and computation of the empty center of gravity within ± .1" of empty center of gravity.

Key Points	*Feedback*
Aircraft specifications.	•How does a mechanic determine the "required" equipment? •How does a mechanic determine the amount of residual fuel? •Why do "notes" pertaining to weight and balance often appear in the aircraft specifications?
Aircraft weight and balance records.	•How does a mechanic determine that the weight and balance records for a particular airplane are current? •How does a mechanic determine the leveling means to be used for a specific airplane?
Weighing procedures.	•What are some of the advantages and limitations to the use of beam and platform type scales? •How is accuracy of a scale used to weigh an airplane verified? •Why are scales "zeroed" after they have been moved into position for weighing the airplane? •What is a tare weight?
Jacking and leveling.	•Where is information identifying the jacking points on a particular airplane found? •Why must an airplane be level when measurements of arms and weight are being made? •What are the factors that influence the selection of a site for weighing an airplane?
Moment arms.	•Why is it a good practice to sketch the relationship of datum, mainwheel and nose or tailwheel centerlines? •What unit of measurement is used in specifying moment arms? •Describe some of the methods which may be used to "damp" or "steady" a plumb line. •What precautions should be observed when measuring with chalk lines or establishing measuring points on the hangar floor?
Reading scales and recording weights.	•Why is it good practice to use an organized form to record weights and moment arms? •Why is it important that the content of all liquid reservoirs in the airplane be known at the time that the weights are recorded?
Nomenclature and algebraic signs.	•Why are plus and minus signs assigned to moment arms? •What is an empty weight of an airplane? •What is an empty center of gravity of an airplane?

Activities	*Check Items*
	Did the student:
Locate and interpret appropriate aircraft specifications.	•Confirm the make and model of aircraft by comparison with the manufacturer's data plate?
Move aircraft to weighing site.	•Exercise caution in moving aircraft? •Select a site undisturbed by wind and air currents?
Position aircraft, jacks and scales for weighing.	•Attach jack pads or points as required? •Verify certification and accuracy of scales? •Assure the security and safety of the jacking and weighing area? •Verify each item of required equipment in the aircraft? •Verify and record quantities of fuel/oil and other variables of moveable load? •Record optional items of equipment as installed? •Verify that the aircraft was clean and all personal items were removed?
Jack and level aircraft.	•Correctly interpret leveling method as specified in publications? •Insure that sufficient personnel were available and coordinated to safely raise the aircraft? •Observe safety procedure during jacking (ballast, chocking, safety signals, signs and rope off area, etc.)?
Establish weight and measurements.	•Correctly establish measurements, read scales and record information on an organized weight and balance form? •Record tare weights?
Lower airplane, return tools and equipment to storage area.	•Observe all safety precautions?
Compute center of gravity.	•Use correct nomenclature and algebraic signs for computations? Achieve required accuracy?

34. PERFORM COMPLETE WEIGHT AND BALANCE CHECK AND RECORD DATA. (EIT = 27 hrs., T = 12 hrs., L/S = 15 hrs.) 5 segments

(UNIT LEVEL 3)

SOLVE WEIGHT AND BALANCE PROBLEMS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's aircraft specifications.
- Performance:
  Provided with the necessary weight and balance information, the student will solve five problems involving computation of the empty center of gravity of an airplane.
- Standard:
  Computation of empty center of gravity will be accurate to one-tenth inch.

Key Points	*Feedback*
Weights for computation.	•How is an "as weighed" weight defined for purpose of weight and balance computation? •How is the weight of residual fuel and oil determined? •What is the importance of a tare weight?
Moment arms.	•With regard to a datum, what is the direction of a negative (minus) arm? •Why isn't the datum located at the main wheel centerline? •What is a datum?
Center of gravity range.	•Why is the center of gravity range often expressed as a percentage of the MAC? •Under what conditions are empty weight center of gravity ranges not valid? •What is an empty weight center of gravity range?
Aircraft categories.	•Explain why the same airplane might have two different maximum gross weights – depending upon category. •Name and describe five aircraft categories.

Activities	*Check Items* Did the student:
Solve five weight and balance problems when given: a. Wheel weights. b. Wheel measurements. c. Datum d. Fuel and oil on board. e. Tare weights.	•Diagram the problem? •Assign algebraic signs to the arms? •Convert fuel and oil quantities to weights? •Determine residual fuel and oil weights? •Adjust computed center of gravity to a datum reference? •Maintain arithmetic accuracy to one-tenth inch?

COMPUTE FORWARD AND AFT LOADED CENTER OF GRAVITY.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Necessary data to compute center of gravity loading on two different aircraft.

- Performance:
  The student will compute the forward and aft center of gravity condition on the specified aircraft. He will describe the hazards associated with exceeding the limits and will determine the necessary ballast, baggage reduction or loading schedule to preclude exceeding the approved limits.

- Standard:
  Problems will be solved to an accuracy of one-tenth inch.

Key Points	*Feedback*
Minimum fuel for weight and balance computations.	•Compare the terms "horsepower" and METO power. •How is horsepower used to compute minimum fuel for weight and balance purposes? •If the minimum fuel is computed by a formula which results in gallons, how is this answer converted to pounds?
Passenger and crew weights.	•For purpose of weight and balance, what is the value of a term such as "fully loaded"? •Where would the maximum gross weight of an airplane be specified?
Baggage placards and ballast.	•What is the difference between fixed and moveable ballast? •Why are maximum baggage placards required in baggage compartments?
Weight and balance envelopes.	•How is the effect produced by the retraction of a landing gear introduced into weight and balance computations? •Describe the hazards of exceeding the forward and aft center of gravity range. •If the maximum take-off weight greatly exceeds the maximum landing weight, what provisions are made in the aircraft?

Activities	*Check Items* Did the student:
Solve a problem where computation of minimum fuel is a factor. Solve a problem involving computation of necessary ballast or baggage reduction. Prepare a placard or loading schedule.	•Determine minimum fuel and correctly express the minimum in pounds rather than gallons? •Achieve required accuracy? •Correctly determine required ballast?

COMPUTE EFFECT OF EQUIPMENT CHANGES AND LOADING SCHEDULES.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  Sample loading schedules and equipment specifications for a specific model of airplane.

- Performance:
  The student will compute the effects of equipment changes on the empty center of gravity of the airplane. He will prepare a loading schedule after solving a problem involving maximum baggage, cargo load or maximum gross loaded center of gravity conditions.

- Standard:
  The computed center of gravity will be accurate to one-tenth inch. The loading schedule will meet FAA and/or manufacturer's requirements.

Major alterations.	•How can a mechanic identify a "standard" item of equipment? What factors identify an "optional" item of equipment? •How does an optional item of equipment affect the weight and balance of an airplane? •How does the installation of optional items of equipment affect the useful load of an airplane? •How does the installation of optional items affect the maximum authorized gross weight of the airplane? The empty weight? •If the optional item of equipment has a greater weight than the required item which it is replacing, what effect does this have on the useful load of the airplane?

Activities	*Check Items* Did the student:
Solve a problem where an item of greater weight is installed forward of the CG. Solve a problem where an item forward of the CG is removed. Prepare a weight and balance record and loading schedule.	•Correctly determine the affect on the empty center of gravity of the airplane? •Use correct nomenclature in preparing the loading schedule? •Maintain required accuracy?

COMPUTE WEIGHT AND BALANCE ON A HELICOPTER.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  Weight, loads and balance information applicable to a helicopter.
- Performance:
  The student will solve one problem requiring computation of center of gravity of a helicopter.
- Standard:
  The computed center of gravity will be accurate to one-tenth inch.

Key Points	*Feedback*
Datum references.	•What position is generally used as a datum for rotary wing aircraft? •Why is the weight and balance of a helicopter critical? •What publication will specify the datum and weight and balance information?
Weighing points.	•How would a mechanic determine the position of the weighing points for a helicopter? •What references would be used to establish the location of items of equipment required for a helicopter?
Weight and balance computations.	•How does the procedure for determining the weight and balance of a helicopter differ from the procedure used with fixed wing aircraft? •In what manner do the weight and balance records for a helicopter differ from fixed wing aircraft?

Activities	*Check Items* Did the student:
Solve a typical helicopter weight, load and balance problem.	•Use correct nomenclature and achieve the required accuracy?

EXAMINE WEIGHT AND BALANCE RECORDS.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:
  Sample files of weight and balance records for three different airplanes.
- Performance:
  The student will examine the records and judge which records are complete, accurate and current.
- Standard:
  The student will select the most complete, accurate and current record from the three sample files.

Key Points	*Feedback*	*Activities*	*Check Items*
			Did the student:
Weight and balance records.	•What action should be taken if it is determined that the weight and balance records are not current? •What action should be taken if weight and balance records or loading schedules for a specific airplane cannot be located? •What should be done if placards called for in the weight and balance records are not installed in the airplane? •Why do the regulations provide that fixed ballast must be placarded?	Review weight and balance record files.	•Select the correct file? •Justify selection?

CHAPTER II

AIRFRAME CURRICULUM INSTRUCTIONAL UNITS

There are two sections included in the Airframe Curriculum: Airframe Structures and Airframe Systems and Components. The instructional units in the Airframe Curriculum, combined with the General Curriculum will provide a student with the necessary technical knowledge and manipulative skills to become a licensed airframe mechanic.

Although a sequence of instruction is presented in this report, the instructional units may be rearranged to better accommodate a particular school's requirements. As in the case of the General and Powerplant Curriculums, the segments under each of the instructional units should remain with the unit if maximum instructional impact is to be achieved.

The total time allotment for this section by FAR 147 is 750 hours. The Airframe Curriculum as shown in this publication provides for 740 hours of instruction. The remaining ten hours may be used for review, additional practice, and/or examinations.

Preceding both the Airframe Structures and the Airframe Systems and Components instructional units is an outline of the instructional units and their segments for each particular sub-division. The estimated time allotment for each instructional unit is also provided; this may be adjusted to meet each particular school's requirements. As with the General and Powerplant Curriculums, an adjustment of time for each instructional unit is permissible as long as it does not jeopardize a student's learning attainment of the other instructional units as specified in FAR 147. The time lag between theory and laboratory/shop instruction should be minimal.

Instructional space, as well as the number, type, and condition of work stations, should be adequate to handle the projects and to safely accommodate the number of students involved. The instructional conditions should be consistent with industrial practices and should provide for the learning of good work habits. Instructional materials and projects should be of the type and quantity which will provide each student with an identical instructional experience. Space must be provided for the disassembly, repair, assembly, test, and service of aircraft and aircraft systems and components. Each of the instructional areas should have accessible storage which protects parts from damage and at the same time allows easy retrival.

As in the case of the other curriculum areas, instructional activities should be related to the student performance goals for each of the segments and should provide sufficient time for practice on level 3 projects. If a school cannot provide the items and/or conditions identified

by a student performance goal, then it should either obtain the necessary materials and projects or rewrite the student performance goal so that it better relates to the materials and projects unique to the school. It is extremely important that student performance goals be directly related to instructional activities if the student is to receive maximum instructional benefit.

OUTLINE AIRFRAME CURRICULUM – PART I, STRUCTURES

Instructional Units, Segments, and Estimated Instructional Time

WOOD STRUCTURES

1.	IDENTIFY WOOD DEFECTS.	- Level 2	2.0 hrs.
A.	Identify defects in wood samples.	- Level 2	
2.	INSPECT WOOD STRUCTURES.	- Level 2	3.0 hrs.
A.	Identify kinds of woods.	- Level 2	
B.	Illustrate the effects of shrinkage.	- Level 2	
3.	SERVICE AND REPAIR WOOD STRUCTURES.	- Level 1	7.5 hrs.
A.	Judge the suitability of substitute materials.	- Level 1	
B.	Describe the kinds of glues and gluing techniques.	- Level 1	
C.	Read drawings pertaining to repair of wood structures.	- Level 1	
D.	Repair of elongated bolt holes.	- Level 1	
E.	Identify protective finishes.	- Level 1	

Estimated Instructional Time . . . . . 12.5 hrs.

FABRIC COVERING

4.	SELECT AND APPLY FABRIC AND FIBERGLASS COVERING MATERIALS.	- Level 1	3.5 hrs.
A.	Identify fabrics and seams and describe methods of applying fabric.	- Level 1	
5.	INSPECT, TEST AND REPAIR FABRIC AND FIBERGLASS.	- Level 3	13.0 hrs.
A.	Inspect, test and repair fabric covering.	- Level 3	

Estimated Instructional Time . . . . . 16.5 hrs.

AIRCRAFT FINISHES

6.	APPLY TRIM, LETTERS AND TOUCHUP PAINT.	- Level	2.0 hrs.
A.	Draw registration numbers and describe the application of trim designs.	- Level 1	
7.	IDENTIFY AND SELECT AIRCRAFT FINISHING MATERIALS.	- Level 2	3.0 hrs.
A.	Identify finishing materials and thinners.	- Level 2	
8.	APPLY PAINT AND DOPE.	- Level 2	22.0 hours
A.	Apply dope.	- Level 2	
B.	Spray primers, dope and paints.	- Level 2	
9.	INSPECT FINISHES AND IDENTIFY DEFECTS.	- Level 2	3.0 hrs.
A.	Inspect finishes and recognize defects.	- Level 2	

Estimated Instructional Time . . . . . 30.0 hrs.

SHEET METAL STRUCTURES

10.	INSTALL CONVENTIONAL RIVETS.	- Level 3	21.0 hrs.
A.	Identify conventional aircraft rivets.	- Level 3	
B.	Perform riveting to FAA specifications.	- Level 3	
C.	Identify, remove and replace improperly installed rivets.	- Level 3	
11.	INSTALL SPECIAL RIVETS AND FASTENERS.	- Level 2	15.0 hrs.
A.	Aircraft types of special rivets and fasteners.	- Level 2	
B.	Select acceptable holes and install hi-shear, blind rivets and deicer-boot fasteners.	- Level 2	
C.	Remove and replace special rivets and fasteners.	- Level 2	
12.	HAND FORM, LAYOUT AND BEND SHEET METAL.	- Level 3	34.0 hrs.
A.	Make a joggle in aluminum sheet.	- Level 2	
B.	Prepare a layout for a bend in aircraft sheet metal.	- Level 2	
C.	Layout and make bends in sheet metal.	- Level 3	
D.	Form aluminum parts by bumping.	- Level 3	
13.	INSPECT AND REPAIR SHEET METAL STRUCTURES.	- Level 3	44.0 hrs.
A.	Select and use twist drills and countersinks.	- Level 3	
B.	Select and use hand files for soft metals.	- Level 3	
C.	Repair shallow scratches in sheet metal.	- Level 2	
D.	Repair a slightly oversize hole by reaming for next larger size rivet.	- Level 3	
E.	Prepare dissimilar metals for assembly.	- Level 2	
F.	Describe loads in fuselage and wing structures and types of overload failure.	- Level 1	
G.	Make minor repairs to stressed-skin wings.	- Level 2	
H.	Repair aircraft structural units built from sheet metal.	- Level 2	
I.	Determine conditions of stressed skin structure which has been critically loaded.	- Level 2	
J.	Construct a watertight joint.	- Level 2	
14.	INSPECT BONDED STRUCTURES.	- Level 2	9.0 hrs.
A.	Inspect and repair metal sandwich structures.	- Level 1	
B.	Evaluate damage to bonded structure and determine type of repair needed.	- Level 2	

15.	INSPECT AND REPAIR PLASTICS, HONEYCOMB AND LAMINATED STRUCTURES.	- Level 2	11.0 hrs.
A.	Identify and repair plastic, fiber and fiberglass aircraft materials.	- Level 2	
B.	Repair damaged areas in fiberglass aircraft structures.	- Level 2	
16.	INSPECT, CHECK, SERVICE AND REPAIR WINDOWS, DOORS, AND INTERIOR FURNISHINGS.	- Level 2	12.0 hrs.
A.	Recognize distinguishing characteristics of transparent plastic and plate glass enclosures.	- Level 2	
B.	Clean, protect, repair and secure transparent plastic aircraft enclosures.	- Level 2	
C.	Inspect and check pressure seal doors and windows, seat recline mechanisms and safety belt installations.	- Level 2	

Estimated Instructional Time . . . . 146.0 hrs.

WELDING

17.	SOLDER, BRAZE AND ARC-WELD STEEL.	- Level 2	32.5 hrs.
A.	Preparation and precautions before soldering, brazing and welding.	- Level 1	
B.	Solder electrical connections and make lap-joints.	- Level 2	
C.	Repair steel parts by welding.	- Level 2	
18.	FABRICATE TUBULAR STRUCTURES.	- Level 1	6.0 hrs.
A.	Tubular steel fabrication and repair by welding.	- Level 1	
19.	SOLDER STAINLESS STEEL.	- Level 1	1.0 hr.
A.	Silver soldering of stainless steel.	- Level 1	
20.	WELDING STAINLESS STEEL AND ALUMINUM.	- Level 2	3.5 hrs.
A.	Inspect and weld aluminum and stainless steel.	- Level 2	
21.	WELD MAGNESIUM AND TITANIUM.	- Level 1	2.0 hrs.
A.	Welding of magnesium and titanium.	- Level 1	

Estimated Instructional Time . . . . . 45.0 hrs.

ASSEMBLY AND RIGGING

22.	RIG FIXED WING AIRCRAFT.	- Level 2	9.0 hrs.
A.	Use correct aircraft nomenclature.	- Level 1	
B.	Interpret theory of flight.	- Level 2	
23.	RIG ROTARY WING AIRCRAFT.	- Level 1	8.0 hrs.
A.	Use nomenclature applicable to rotary wing aircraft.	- Level 1	

24. CHECK ALIGNMENT OF STRUCTURES. - Level 2 10.0 hrs.

    A. Verify alignment of structures. - Level 2

25. ASSEMBLE AIRCRAFT. - Level 3 7.0 hrs.

    A. Assemble components. - Level 3

26. BALANCE AND RIG MOVABLE SURFACES. - Level 3 24.0 hrs.

    A. Identify aircraft control cable. - Level 2

    B. Install swaged cable terminals. - Level 3

    C. Verify correct control response. - Level 2

    D. Install and tension a control cable, inspect a cable control system. - Level 3

    E. Check static balance of a control system. - Level 3

    F. Inspect and adjust push-pull control systems. - Level 3

27. JACK AIRCRAFT. - Level 3 3.0 hrs.

    A. Jack aircraft. - Level 3

Estimated Instructional Time . . . . 61.0 hrs.

AIRFRAME INSPECTION

28. PERFORM AIRFRAME CONFORMITY AND AIRWORTHINESS INSPECTIONS. - Level 3 20.0 hrs.

    A. Perform 100-hour or annual inspection. - Level 3

Estimated Instructional Time . . . . 20.0 hrs.

Total Estimated Instructional Time . . . . 331.0 hrs.

WOOD STRUCTURES

1. IDENTIFY WOOD DEFECTS. (EIT = 2 hrs., T = 1 hr., L/S = 1 hr.) 1 segment

(UNIT LEVEL 2)

IDENTIFY DEFECTS IN WOOD SAMPLES.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  AC 43.13–1 or equivalent publication, random samples of aircraft wood, some of which contain the defects described in AC 43.13-1.
- **Performance:**
  The student will interpret the information contained in AC 43.13-1 and select those samples of wood that would be acceptable for repair of wood aircraft structures.
- **Standard:**
  The defects will be identified and the reference specifications interpreted without error.

Key Points	*Feedback*
Selection of wood.	• What is meant by the term "aircraft quality" wood? • What kind (species) of wood is considered as the "standard" for judging the quality of structural wood members of the airplane? • Identify and describe the working and strength characteristics of two kinds of wood which may be used as substitutes for spruce.
Identification of defects.	• Using the tables contained in AC 43.13–1, interpret the acceptable limits for five of the wood defects described: a. How would a mechanic measure a pitch pocket? b. How could grain slope or grain divergence be detected? • Explain why pitch pockets would be considered more critical if they were located in the edge or spar cap of a wood spar. • What limitation is imposed by AC 43.13–1 to the acceptance of mineral streaks in a piece of aircraft spruce? • How would a mechanic identify a compression failure in a piece of aircraft spruce? • Describe in your own words what is meant by the term "brash." • What physical characteristics might indicate "dry rot" in a piece of spruce? • Explain why a single knot in a piece of spruce is not sufficient cause for rejection of that piece of material. • What is meant by the terms, spiral/diagonal/interlocked/wavy/curly grain?

Activities	*Check Items* Did the student:
Interpret defect specifications.	• Readily locate and accurately interpret information from AC 43.13–1?
Identify defects in samples.	• Use correct nomenclature to describe reasons for acceptance or rejection of the sample? • Detect defects and make correct judgment of acceptability?

2. INSPECT WOOD STRUCTURES. (EIT = 3 hrs., T = 1½ hrs., L/S = 1½ hrs.) 2 segments

(UNIT LEVEL 2)

IDENTIFY KINDS OF WOODS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Random samples of aircraft parts made of plywood, laminated and solid wood, and a list of the various kinds of aircraft quality wood.
- **Performance:**
  The student will identify each type of wood used in the structure, and describe the strength characteristics which influence the selection of such materials for repair of wood aircraft structures. The student will arrange the list of woods in a descending order of strength.

- **Standard:**
The student will identify five species and three forms of aircraft wood, and interpret information from AC 43.13–1 without error.

Key Points	*Feedback*
Forms of wood in aircraft structures.	• What are some of the advantages of laminated and plywood members over solid wood members? • What regulations govern the substitution of solid for laminated type spars? • What considerations govern the substitution of solid reinforcing plates for plywood reinforcing plates? • Which type of wood is most susceptible to warping? • What physical characteristic determines whether a member is classified as a laminated section or plywood?
Species of wood.	• What is the difference between a hardwood and a softwood? • Which kind of wood will most likely fail by splintering? • When sawing or planing spruce and douglas fir, which kind of wood is most likely to splinter?

Activities	*Check Items* Did the student:
Identify the kind of wood used in sample parts.	• Recognize plywood and laminated wood structure? • Distinguish between spruce and douglas fir wood members? • Identify birch and mahogany face plywood?
Identify the comparative strength of wood by listing in descending order or strength.	• Arrange the listing of kinds and types of wood in the correct order? • Use correct nomenclature as a part of the description?

ILLUSTRATE THE EFFECTS OF SHRINKAGE.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
AC 43.13–1 or other appropriate reference information.

- **Performance:**
The student will interpret information pertaining to the effect of moisture on the size and strength of wood structural members. The student will make a sketch illustrating the change in dimensions (shrinkage effects) due to variations in the moisture content.

- **Standard:**
The student will use correct nomenclature to describe the strength and dimensional changes in tangential, radial and longitudinal directions.

Key Points	*Feedback*
Effects of moisture in wood.	• How does the strength of wood vary with changes in moisture content? • How does the size (dimensions) of a wood member vary with changes in moisture? • In which direction does the greatest dimensional change occur? • How does shrinkage in a wood member affect the alignment of a structure? • What methods may be employed to minimize shrinkage cracks at plywood reinforcing plates? • What methods will minimize the loosening of fittings due to shrinkage?

Activities	*Check Items* Did the student:
Make sketch interpreting and illustrating shrinkage.	• Correctly identify tangential, radial and longitudinal directions? • Correctly interpret information in relation to changes in dimensions? • Use correct nomenclature as a part of the description?

3. SERVICE AND REPAIR WOOD STRUCTURES.

(EIT = 7½ hrs., T = 7½ hrs., L/S = 0 hrs.)
5 segments

(UNIT LEVEL 1)

JUDGE THE SUITABILITY OF SUBSTITUTE MATERIALS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
A list containing the names of five kinds of wood and AC 43.13–1 or other appropriate reference information.

- **Performance:**
Using reference information, the student will select at least two substitute species that exceed the strength properties of aircraft spruce.

- **Standard:**
The student will select two substitute species without error.

Key Points	*Feedback*
Use of references to determine species substitution.	• What publications are generally accepted as guides to substitution of materials? • Who is authorized to accept material substitutions? • What considerations apply if the substitute materials are heavier than the original spruce structure? • Why wouldn't a hard wood be an acceptable substitute for a softwood member?

DESCRIBE THE KINDS OF GLUES AND GLUING TECHNIQUES.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- **Given:**
Advisory Circular 43.13–1 or other suitable reference information.

- **Performance:**
The student will describe the preparation of wood surfaces for gluing, the types and characteristics of acceptable glues, spreading of glues, assembly time in gluing, gluing pressures and methods of applying pressures.

- **Standard:**
The student will locate information in the reference publications and use correct nomenclature as part of the description and explanation of procedures.

Key Points	*Feedback*
Glues and gluing techniques.	• Why isn't a roughened surface recommended as a surface for gluing? • Why shouldn't the gluing surfaces of softwoods be sanded as a preparation for gluing a joint? • Why should the joint be assembled as soon as possible following preparation of the gluing surfaces? • What is the affect of curing temperature to the strength of a glued joint? • Which type of glue is most moisture resistant? • Explain the terms "open assembly" and "closed assembly" as applied to the assembly of a glued joint. • What features will identify a glued joint that has been assembled with insufficient pressure? • Describe the procedure that should be followed to mix casein glue. • If the glue mixture is too thin, or the pressure applied to the joint is excessive, how would the strength of the joint be effected? • What types of clamps should be used to apply pressure to a glued joint? • Why are pressure blocks important when clamping a spar splice? • How is clamping pressure most generally applied to the gussets of ribs? • How may pressures be applied to glued joints in plywood skin patches? • What may happen if excess glue is not removed from the wood surrounding a glued joint? • Why does the glue manufacturer generally recommend that glue be applied to both surfaces of the joint? • What procedure may be used to extend the working life of a synthetic resin glue?

- What precautions must be observed with respect to the working life of casein glue which has been mixed for a wood repair joint?
- What is the correct proportion of glue and water when mixing casein glue?
- What time period is required before a glued joint develops its full strength?
- What effect does high air temperature have on the assembly time of a glued joint?
- What effect would old glue, varnish or other foreign materials have on the strength of a glued joint?

READ DRAWINGS PERTAINING TO REPAIR OR WOOD STRUCTURES.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- Given:
  AC 43.13–1 or equivalent reference information, and an information sheet containing six undimensioned drawings of typical scarf joints.
- Performance:
  The student will locate information applicable to the scarf splice joints described in AC 43.13–1. He will read the diagrams and drawings and apply the dimensions to sketches of typical wood structural repairs.
- Standard:
  Correctly determine ratio dimensions for five undimensioned drawings or sketches of typical structural repairs.

Key Points	*Feedback*
Spar repair procedures.	•Why aren't spars spliced at the fittings? •Why is it considered acceptable practice to lap reinforcing plates over a compression member providing that the plates are on the front face of the front spar or the rear face of the rear spar? •Why can't spruce reinforcing plates be substituted for plywood reinforcing plates? •Why are the ends of reinforcing plates often feathered or shaped to a "spaded" end? •What repair procedure should be followed if cracks are found extending beyond the ends of a plywood reinforcing plate? •Describe the difference between a longitudinal crack in a spar and "local damage" to a spar. •How are metal ribs attached to a wooden spar? •What is the difference between a standard rib and a compression rib? •What is a false rib? An aileron rib? •Is the scarf slope for a rib capstrip cut vertically or horizontally? •Describe how old, dry varnish is removed from a surface before gluing.
Rib repair procedures.	•What considerations dictate whether a rib repair is made: a. At the spar location? b. At a rib joint? c. Between rib joints? d. At the trailing edge? •What precautions must be taken when accomplishing rib repairs to ensure the maintenance of contour? •As a part of the assembly operation, what is meant by alignment and tramming of a wing?
Plywood skin repair procedures.	•What factors determine the limiting radius to bends in plywood skins? •Describe why an overlay patch might not be acceptable at the leading edge of a plywood stressed skin wing. •Why is the direction of the face grain critical to the strength of a plywood patch?
Dimensioning sketches.	•How is the information in AC 43.13–1 used in drawing dimensions on sketches of typical wood structural repairs?

	•How are typical scarf joints dimensioned on drawings? •How are dimensional limits indicated in AC 43.13–1?

REPAIR OF ELONGATED BOLT HOLES.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- **Given:**
  AC 43.13–1 or equivalent reference information.
- **Performance:**
  The student will describe the procedures and methods of repairing elongated bolt holes in wood spars.
- **Standard:**
  At least two methods of repair will conform to AC 43.13–1.

Key Points	*Feedback*
Elongated bolt holes.	•What factors contribute to the condition generally described as "elongated" bolt holes in spars? •How does the use of a bushing minimize the tendency to elongate the hole in a spar? •How does the use of a plywood reinforcing plate at the hole location minimize the tendency to elongate the hole? •What records are necessary to certify the repair of elongated bolt holes? •If the bolt holes in the butt section of a spar are elongated, which repair procedure would be preferred?

IDENTIFY PROTECTIVE FINISHES.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- **Given:**
  AC 43.13–1 or equivalent reference information and 5 samples of acceptable and unacceptable finished wood aircraft structures.
- **Performance:**
  The student will use the reference information as an aid in describing the materials and procedures approved to seal wood aircraft structures, and recognize acceptable finishes.
- **Standard:**
  The student will recognize those sample finishes that are acceptable.

Key Points	*Feedback*
Protective finishes.	•Why is the protective finish applied to the end grain of a spar of particular importance? •What is the importance of a dope-proof paint? •Describe the procedure that should be followed to seal the interior surface of a wood structure that will be assembled by gluing. •Name three finishes that are considered dope-proof. •What problem may result from varnishing over extruded glue that surrounds a joint? •Why should all grease, oil and wax be removed before applying the protective finishes?

4. SELECT AND APPLY FABRIC AND FIBERGLASS COVERING MATERIALS. (EIT = 3½ hrs., T = 3½ hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

IDENTIFY FABRICS AND SEAMS AND DESCRIBE METHODS OF APPLYING FABRIC.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  AC 43.13–1 or equivalent reference publications; samples of cotton, linen and synthetic textile materials and samples of doped and sewed seams.

- Performances:
  Using the references, the student will identify aircraft textiles (both before and after doping) and identify the correct fabric to be used in covering an aircraft when the airspeed and wing loading is specified. He will compare the samples of doped and sewed seams with the specifications appearing in the publications. He will describe the acceptable methods of applying fabric.

- Standard:
  The student will locate reference information. He will identify the kind of fabric without error. He will correctly judge whether the sample seams conform to the specifications, and correctly describe methods of applying fabric.

Key Points	*Feedback*
Kinds of textile materials.	•Name four factors that are considered when selecting the kind and quality of fabric that will be used in recovering an airplane. •What are some of the factors which affect the costs of aircraft recovering? •Compare the relative durability of the various kinds of fabric. •How do the different kinds of aircraft fabric compare in strength? •How do the different kinds of textile materials compare with regard to workability and ease of repair?
Sewed seams.	•Compare the relative strength of a plain overlap, French fell and a folded fell seam. •When fabric must be sewn together to cover a structure, where should the seams be located? •What is the limitation or disadvantage to the use of a plain sewed seam? Is there any advantage?
Doped seams.	•What limitations are applicable to the use of doped seams? •Describe the requirements for overlapping doped seams at the wing leading edge.
Covering practices.	•What is the purpose of inter-rib bracing? •Describe two methods of determining correct rib stitch spacing. •What is the difference between an envelope and a blanket method of covering? •What is the purpose of reinforcing tape? When are anti-tear strips required? •What is the purpose of rib-stitch or lacing cord? •What effect does the maximum design airspeed have upon rib stitch spacing? •Describe (in addition to lacing cord) two other methods of attaching the fabric to the structure. •What is the purpose of pinked edge or surface tape in the covering of an airplane?

5. INSPECT, TEST AND REPAIR FABRIC AND FIBERGLASS. (EIT = 13 hrs., T = 4 hrs., L/S = 9 hrs.) 1 segment

(UNIT LEVEL 3)

INSPECT, TEST AND REPAIR FABRIC COVERING.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Maule and/or Seyboth fabric tester, a fabric covered aircraft structure, AC 43.13–1 or equivalent reference information, and the materials and tools necessary to make repairs to fabric.

- **Performance:**
  The student will inspect a fabric covered aircraft structure, and identify the areas most susceptible to corrosion. He will perform fabric strength tests, and make both doped and sewed repairs in accordance with AC 43.13–1.

- **Standards:**
  The inspection, testing and repairs will be of return-to-service quality.

Key Points	*Feedback*
Factors effecting deterioration in structure and fabric.	• Where is corrosion and deterioration most likely to be found? • How will moisture, poor ventilation and inadequate drainage contribute to corrosion and deterioration? • How does sunlight effect fabric? • What protective finishes may minimize deterioration of the fabric covering? • Why is it important that corrosion and deterioration be detected? • What results when a structure is infested with insects, birds and varmints? • What factors determine whether a fabric covered structure is airworthy?
Testing fabric covering.	• Why is fabric strength tested? At what time intervals is it usually tested? • Compare the reliability of two common methods of testing fabric strength. • From which areas of the aircraft are the sample "strips" taken? In which areas are "punch" tests made? • What are some of the precautions in using and interpreting the readings of a "punch" tester? • Is the fabric tester designed to test fabric strength or the strength of the dope film? • What factor of aircraft performance limits the repair of fabric by doped-on patches? • What tests could be made to determine the kind of dope that has been originally used on the fabric? • What publication classifies the repairs as major or minor repairs? • What sequence of operation or procedure is recommended when sewing an "L" shaped tear? • Under what circumstances would it be necessary to rib stitch a patch? • What procedure is most effective in removing the original dope – as a prelude to doping on a patch? • What precautions are involved when patching fabric on movable control surfaces?

Activities	*Check Items*
	Did the student:
Inspect for deterioration and identify critical areas.	• Remove inspection cover plates? • Critically inspect areas most susceptible to corrosion/deterioration?
Perform fabric test.	• Select appropriate area for testing? • Correctly use tester and interpret results?
Apply a doped-on patch.	• Correctly interpret and follow the prescribed procedure?
Hand sew a tear in fabric (minimum 4 inch dimension).	• Make an appropriate entry (or simulated entry) in the aircraft maintenance records? • Make a return-to-flight repair?

6. APPLY TRIM LETTERS AND TOUCHUP PAINT. (EIT = 2 hrs., T = 2 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

DRAW REGISTRATION NUMBERS AND DESCRIBE THE APPLICATION OF TRIM DESIGNS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Appropriate Federal Air Regulations, and graph paper.
- **Performance:**
  Using Federal Air Regulations, Part 45 as a reference, the student will locate that information which establishes the location, size and display of aircraft registration markings on Civil Aircraft of United States Registry. On grid or graph paper, the student will draw the letters and numbers used as registration marks, and describe the application of trim and methods of touching up paint.
- **Standard:**
  The student will maintain the correct height, width, stroke and spacing. Description will comply with information provided.

Key Points	*Feedback*
Registration markings.	• Where are the registration markings positioned on a fixed wing airplane? Where are the markings placed on rotary wing craft? • How are registration numbers assigned and issued to a specific airplane? • Is there any significance to the use of five numbers following the letter N? Describe a condition in which less than five numbers will be issued? • Why do the current regulations require registration numbers on both sides of the fuselage when older regulations provided for display of the numbers on the wings? • What is the procedure for changing a registration number that has been assigned to an airplane?
Size and spacing of markings.	• What is the size and spacing of registration numbers assigned to an airplane? • Do the regulations establish the height and width as minimum dimensions — or are these sizes mandatory? • What is meant by the term "stroke" of the letter? • Is there any artistic tolerance permitted in the spacing dimension between letters?
Color, embellishment, ornamentation and trim.	• What is implied by the requirement for a "clearly contrasting color"? • If the registration markings must be a "block" form letter, what limits would apply to the use of "slant" or inclined letters? • If the owner or operator of the airplane wants to incorporate his own trademark or trim design along with the registration number, what FAA requirements must be met? • If markings indicating foreign registry of an airplane are applied to an airplane while it is operating within the airspace of the United States, what other regulations apply?
Application of trim designs and touchup paints.	• How are registration numbers applied to/or attached to an airplane structure? • What are some of the problems that may be encountered when painting a registration number on an enamel, lacquer, or a polished, unpainted aluminum surface? • What are some of the precautions to be observed when masking registration numbers on trim designs prior to the application of paints? • When using masking paper, what is the importance of selecting a paper that will not "bleed through"?
Application of decalcomanias.	• What are the uses and advantages of decals?

- Where are instructions usually found for applying decals?
- What are decals coated with after they have been applied to the aircraft surface?

7. IDENTIFY AND SELECT AIRCRAFT FINISHING MATERIALS. (EIT = 3 hrs., T = 2 hrs., L/S = 1 hr.) 1 segment

(UNIT LEVEL 2)

IDENTIFY FINISHING MATERIALS AND THINNERS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Labeled samples of nitrate and butyrate dope, lacquer, zinc chromate primer and enamel, and appropriate thinners.

- **Performance:**
  The student will examine the labeling and physical characteristics of each sample and select the thinner which would be used with each of the sample materials. He will be able to distinguish between lacquer and enamel by physical examination of the material.

- **Standard:**
  Select an acceptable thinner for each of five finishing materials. Correctly distinguish between lacquer and enamel.

Key Points	*Feedback*
Kinds of dope.	• Describe the results of mixing nitrate and butyrate dope. • What test could be made to determine whether the original finish was nitrate or butyrate? • What are some of the advantages and limitations of nitrate dope? Butyrate dope?
Rejuvenator.	• What is the purpose of a rejuvenator? How does rejuvenator differ from dope?
Lacquers and enamels.	• What is the difference between lacquer and enamel? • Describe the results of mixing lacquers and enamels.
Primers, dope and acid-proof paints.	• Why is there such a wide variety of primers and special purpose paints? • What special precautions apply to the mixing and application of special finishes that require a "catalyst"?
Thinners and reducers.	• Why may some thinners also be called "reducers"? • What is implied by the term "vari-temp" thinner? • What is a retarder? What is its function in the thinning of dope? • What precautions should be observed to ensure that thinners are correctly identified before pouring them into a finishing material?

Activities	*Check Items* Did the student:
Examine and identify samples of nitrate dope, butyrate dope, lacquer, primer, enamel. Select thinners for each sample material.	• Distinguish between lacquer and enamel? • Select an acceptable thinner for each of the finishing materials?

8. APPLY PAINT AND DOPE. (EIT = 22 hrs., T = 4 hrs., L/S = 18 hrs.) 2 segments

(UNIT LEVEL 2)

APPLY DOPE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  A fabric covered structure, covering and finishing materials and a procedure sheet or written instructions.

- **Performance:**
  The student will apply dope by brush and spray application. He will apply surface tapes, drain grommets and reinforcing patches as a part of the doping procedure.

- **Standard:**
  The resultant fabric-/doped surface will comply with the requirements of AC 43.13–1.

Key Points	*Feedback*
Application of dope.	• Why is dope usually brushed at a "full-bodied" or unthinned consistency?

Key Points	Feedback
	•What are some of the advantages and disadvantages to the use of butyrate dope?
	•Describe a procedure that will ensure penetration of the dope and saturation of the fabric without the detrimental effect of runs and sags.
	•What is meant by "scuff" sanding? Is scuff sanding done wet or dry?
Application of surface tapes, drain grommets, inspection rings and reinforcing patches.	•What is the advantage of applying surface tapes, etc., with the second coat of dope? •What determines the proper location of grommets, inspection rings and reinforcing patches? •Describe a practice that will minimize the entrapment of air beneath tapes and patches.

Activities	*Check Items*
	Did the student:
Apply dope to fabric by brushing.	•Follow recommended procedures?
Apply tapes, grommets, inspection ring and reinforcing patches.	•Achieve a doped surface complying with the requirements of AC 43.13–1?

SPRAY PRIMERS, DOPE AND PAINTS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Written procedures, assorted primers, dope and paints, spray painting equipment and facilities, aluminum and fabric covered aircraft structures.
- **Performance:**
  The student will prepare the surfaces for painting and apply primers, dopes and paints by spraying.
- **Standard:**
  The preparation of the surface and spray application of finish must be of return-to-flight service quality.

Key Points	*Feedback*
Surface preparation.	•Why is the surface of an aluminum alloy cleaned and etched before priming?
	•Where would information specifying the correct thinner to be used with a primer be found?
	•Why are primers used before applying the finishing coats of enamel or lacquer?
	•What is the advantage to "wet sanding" a finish?
Use of spray gun.	•What is the difference between a suction type and a pressure type of spray gun? •What factors indicate proper functioning of a spray gun? •Describe the adjustments of a spray gun which permit control of the fluid quantity and spray pattern. •What is an airless spray gun? What is an electrostatic spray gun? •What faulty operator technique will probably result in: a. Runs and sags in the sprayed finish? b. Overlaps? c. High and low gloss in the finish? d. Blushing? •What are some of the factors that influence the consistency of the materials that are to be sprayed?

Activities	*Check Items*
	Did the student:
Prepare clean, etch and prime surface.	•Follow prescribed procedure? •Demonstrate acceptable technique?
Spray dope and paint.	•Select and use correct materials?

9. INSPECT FINISHES AND IDENTIFY DEFECTS.

(EIT = 3 hrs., T = 1 hr., L/S = 2 hrs.) 1 segment
(UNIT LEVEL 2)

INSPECT FINISHES AND RECOGNIZE DEFECTS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
AC 43.13-1 or equivalent information, random sample aircraft parts in which the finishes contain defects that are usually associated with spray painting.

- **Performance:**
The student will recognize the kind of material that was originally applied as a finish. He will describe which finishing materials may be applied over the original finish. He will recognize defects in the finishes of the sample parts.

- **Standard:**
Recognize 70 percent of the original finishes, and all defects, and correctly identify the finishing materials that may be used over an original finish.

Key Points	*Feedback*
Compatibility of finishing materials.	• What simple test may be made to determine whether a finishing material may be sprayed over an original finish? • What reference information should be used as a guide to the mixing and application of finishes?
Identify cause of defects.	• What are the factors that contribute to the following defects: a. Orange peel? b. Pebble effect? c. Runs, sags? d. Laps, streaks, high and low spots? e. Blisters? f. Pinholes? g. Blushing? h. Peeling/flaking?

Activities	*Check Items*
	Did the student:
Identify samples of: a. Dope finishes. b. Lacquer finishes. c. Enamel finishes. d. Primer finishes.	• Recognize the original finishing material and name the materials which could be applied over this original finish?
Recognize the defects in the finishes.	• Properly use and interpret information provided?

10. INSTALL CONVENTIONAL RIVETS. (EIT = 21 hrs., T = 5 hrs., L/S = 16 hrs.)

3 segments

(UNIT LEVEL 3)

IDENTIFY CONVENTIONAL AIRCRAFT RIVETS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

● **Given:**
Written information, charts, AC 43.13–1 or equivalent publication, a supply of aircraft rivets including rivets of various diameters, lengths, head styles, and alloys, and ten questions concerning the properties and uses of aircraft rivets.

● **Performance:**
The student will select thirty different aircraft rivets and identify each rivet by head style, alloy diameter and length of shank. He will answer ten questions concerning rivet identification, properties of heat-treated rivets, and factors that determine the use of specific types of rivets in aircraft.

● **Standard:**
Correctly list at least twenty-four different rivets, and correctly answer eight test questions.

Key Points	*Feedback*
Conventional aircraft rivets.	•What kinds of metal are used in aircraft rivets?
a. Type of alloys used.	•How is the type of alloy of a specific rivet identified?
b. How measured.	•What tools may be used to measure rivet diameters and lengths? •What are the fractional graduations of standard rivet lengths? Diameters?
c. Head styles.	•What determines the type name of a rivet? •How can the correct rivet head type be determined for any specific aircraft riveting application? •Which shape of head is considered to be the strongest?
Rivet hardness and strength.	•What problems would be encountered when attempting to install a hard rivet in soft metal sheet? •What method is used to soften rivets that are too hard for proper setting as they are received? •Describe in descending order of strength, the designation of the aluminum alloys, from which rivets are manufactured. •What are the requirements and limitations for use of 2117 rivets to replace 2017 and 2024 rivets?
Material applications.	•Where can 1100 rivets of pure aluminum be used? •What rivets must be used for magnesium alloy structures? •Where are corrosion resistant steel and Monel rivets used? •Name some applications for copper or brass rivets.

Activities	*Check Items*
	Did the student:
Identify rivets as to type of metal, or alloy, hardness and head shape.	•Recognize head shape and alloy markings?
Measure rivet diameters and length.	•Use correct nomenclature? •Use correct measuring methods?

PERFORM RIVETING TO FAA SPECIFICATIONS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

● **Given:**
Written instructions or drawings, AC 43.13–1 or equivalent publication, samples of aluminum alloy sheet material of various thicknesses and alloys, AN 470 rivets of various alloys, tools for drilling and riveting, rivet heat-treating equipment.

● **Performance:**
The student will cut two 3½" by 5" sections each, of the following aluminum alloys: 7075–T6, 2024–T3, 2017 Alclad, in gauges .032 to .064. He will layout each hole plan, drill holes, install proper type and length rivets for a four row lap splice of 2024–T3 sections, using 3/32" protruded head rivets; and a

(continued)

single row lap splice of 2017 Alclad sections, using 3/16" protruded head rivets. He will use an airpowered riveting gun, select rivet sets and bucking bars suitable for each type of rivet used, and install heat treat rivets when necessary.

- **Standard:**
  Work procedures will comply with the information provided. The riveted sections will have 75 percent of the rivets properly spaced and 75 percent of the rivets installed to meet the specifications in AC 43.13–1 or equivalent publication.

Key Points	*Feedback*
Conventional rivets.	• What tools are used to measure material skin thickness? • What tools are used to measure the diameter of a rivet? Length of a rivet?
Preparing for installation of rivets.	• Where are the requirements for rivet spacing in lap joints to be found? • What is the procedure for preparing a hole for a flush head rivet? A protruding head rivet? • What layout procedure should be followed to assure drilling holes at proper locations?
Importance of proper drilling procedures.	• What happens if a drill has been sharpened off-center? • What effect does failure to deburr a hole have on a riveting job? • How can the correct drill size be determined?
Relation of hole size to rivet diameter.	• Why is a rivet hole drilled slightly larger than the rivet shank diameter? • What problems would be encountered if a drill was undersize for the rivet? • When a rivet of the correct length is driven in an enlarged hole, what is the effect on the dimensions of the upset head? • What generally results if rivets are too closely spaced?
Thin skin riveting.	• What would probably result from using a large diameter rivet in thin skin sheets? • Explain why thin skin sheets are usually dimpled, but heavier sheets are often countersunk. • What will happen if the rivet set or the bucking bar touches the plate being riveted?
Selection of proper riveting gun. a. As to force. b. As to speed.	• Describe the relation between the force setting of the gun and the diameter and hardness of the rivet. • What problems are most likely if a fast light hitting gun is used on relatively large diameter rivets? • What problems would be encountered if the bucking bar is "too light" for the rivets being driven?
Heat treatment of rivets prior to use.	• What types of rivets require heat treatment prior to use? • What is the reason for this requirement? • How is the heat treatment to be accomplished? • What is the quenching procedure? • If rivets cannot be installed immediately after heat treating and quenching, how can they be held in a quenched condition?
Tools to use for riveting.	• What are the tools needed for installing rivets in aircraft skin? • What difference would there be in tools selected for riveting formed structure members? • What extra equipment is needed when heat treatment of rivets is required for the rivets prior to their use?
Riveting practices to be avoided.	• Sketch an example of a rivet in tension and in shear. • Describe other riveting practices that should be avoided.
Selection of rivets.	• How does the type of material to be riveted influence the selection of rivets? • How can the required rivet length be determined? • What factors influence the diameter of rivet to be selected?

	•What factors determine the kind of head to be used?
Selection of correct rivet set and bucking bar.	•What factors determine the selection of the proper type of rivet set to use for a specific type of rivet? •What will be the result of using a rivet set of wrong head style or diameter?

Activities	*Check Items*
	Did the student:
Select and cut 3½" X 5" sections of 2014–T6, 2024–T3, and 2017 Alclad in various thickness gauges.	•Properly identify the various alloys? •Cut sections in a workmanlike manner?
Select rivets of flush and protruded head styles and specified diameters which are of appropriate length for the thickness of the sections to be riveted.	•Carefully select correct rivets for each riveting project? •Identify which rivets require heat treatment prior to use?
Perform heat treatment and quenching of rivets.	•Properly use heat oven for rivet heat treating? •Properly quench the rivets after heating?
Hold quenched rivets on dry ice until ready for use.	•Prepare an adequate number of rivets?
Plan and layout four row, double row and single row lap splices.	•Follow specifications for spacing of rivets for the type of splice and rivets?
Use scrap plates or flanges for practice drilling and riveting.	•Use drill of proper type and speed?
Drill holes through both sections to be spliced and countersunk where flush rivets are to be installed.	•Deburr holes? •Countersink to proper depth? •Avoid separation of plates while drilling? •Assure that rivet holes are of accurate size, and perpendicular to surface?
Select riveting gun, rivet sets and bucking bars.	•Select proper speed gun and set for proper force? •Use proper rivet sets for type of rivets being installed?
Install rivets in holes already drilled using quenched rivets where called for in FAA specifications.	•Use proper bucking bar? •Hold bucking bar in proper position? •Check rivet charts to determine type and length of rivet for each application?

	•Set rivets without marking or warping the plates?

IDENTIFY, REMOVE AND REPLACE IMPROPERLY INSTALLED RIVETS.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
  Aircraft type riveted splices and joints; four row, double row and single row lap splices previously made by the student; AC 43.13–1 or equivalent publication, and written information concerning aircraft rivet installation and removal.

- **Performance:**
  The student will inspect riveted splices and joints, of the type used in aircraft skin and structure, to identify rivets which are faulty. He will inspect the four row and single row lap splices he previously made and remove all rivets which fail to meet specifications. He will replace all removed rivets with equivalent rivets. He will remove all rivets in the double row splice and replace one half with same type and size rivets.

- **Standard:**
  Locate at least 75 percent of all faulty rivets in accordance with specifications provided. At least 75 percent of removed rivets will have holes drilled to meet specifications and 80 percent of replaced rivets will meet FAA specifications.

Key Points	*Feedback*
Causes of rivet defects.	•What defects develop from poorly drilled holes? •What defects develop from improper driving and rivet set usage? •What defects develop from improper bucking bar usage?
Criteria for replacement of questionable rivets.	•What structural considerations influence the decision on rivet replacement? •What determines whether an under-driven rivet may be reset? •How is a rivet removed?
Removing faulty rivets.	•What size drill should be used relative to the shank diameter of the rivet? •How is the drill kept centered? •How is the head removed? •How is the shank removed?

Precautions in removing rivets.	•What precautions should be taken when removing rivets from thin sheets by drilling? •What is the danger in replacing loss rivets with oversize rivets in thin sheets? •What are the dangers of drilling oversize holes in structures or edges of sheets?
Replacement of heat treated rivets.	•Under what considerations may a heat treated rivet be replaced by a non-heat treated rivet?

Activities	*Check Items*
	Did the student:
Inspect riveted splices and joints in aircraft type structures and identify defects.	•Use height and diameter gauges? •Line-sight rivet rows? •Recognize defects from improper driving and bucking?
Remove rivets.	•Drill hole through head and remove head, then punch out the shank properly?
Install replacement rivets.	•Use similar or equivalent rivets for replacement?
Follow specifications when substitution of different type or size of rivet is necessary.	•Use proper procedures when oversized rivets are required? •Use proper procedures for heat treated rivets where required?

11. INSTALL SPECIAL RIVETS AND FASTENERS.

(EIT = 15 hrs., T = 5 hrs., L/S = 10 hrs.)
3 segments

(UNIT LEVEL 2)

AIRCRAFT TYPES OF SPECIAL RIVETS AND FASTENERS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
Written information, AC 43.13–1 or equivalent publication, questions pertaining to special rivets and fasteners used in aircraft and samples of such rivets and fasteners.

- **Performance:**
The student will answer fifteen questions concerning precautions necessary for proper fit when installing special hi-shear and pull-type rivets, the stresses that such rivets are designed to resist, applications and limitations for the use of special rivets and fasteners in aircraft repairs. He will identify and list by type eight different special rivets and fasteners used in aircraft.

- **Standard:**
Correctly answer at least twelve questions and correctly identify at least six types of special rivets.

Key Points	*Feedback*
Kinds of special rivets used in aircraft repair. a. Pull-type and explosive rivets.	•What are some uses of pull-type rivets? •Where may explosive rivets be used? •In what part of the aircraft structure would pull-type and/or explosive rivets be used?
b. Hi-shear rivets.	•When is it permissible to replace solid rivets by blind rivets? •What advantage does a hi-shear rivet have over a conventional rivet? •Compare the strength of a hi-shear rivet to a standard hex-head aircraft bolt. •What type of stresses are hi-shear rivets designed to resist?
c. Riv-nuts and Dill nuts.	•What are some aircraft uses of Riv-nuts and Dill nuts? •How are they installed? •What design feature prevents rotation of a Riv-nut in the mounting? •Where is information on their use to be found?
d. Huck bolts.	•How does a Huck Lockbolt differ from a Huck rivet? •What are some aircraft applications of Huck Lockbolts? •How are they driven?
Quick disconnect fasteners.	•Describe at least three kinds of quick disconnect fasteners in aircraft use. •How can each of these fasteners be replaced when faulty?
Precautions when using special rivets.	•What precautions are necessary when drilling holes for hi-shear rivets? •When installing flush head hi-shear rivets, what are the precautions when countersinking for the heads? •What indication will identify a hi-shear rivet that is too long or too short?

	What is the indication of a pull-type rivet that is too long for the thickness of sheets being joined?
Removal and installation procedures for special rivets and fasteners.	Why is the size of hole in the sheets critical when installing pull-type blind rivets? What is meant by the term "interference" fit? How can the collar be removed from a hi-shear rivet? Describe how the swaged collar can be removed from a Dzus fastener?
Attachment and retention of special fasteners.	How are Dzus springs attached to the structure? How are Cam-loc and Airloc fasteners retained in the structure?

SELECT ACCEPTABLE HOLES AND INSTALL HI-SHEAR RIVETS, BLIND RIVETS AND DEICER BOOT FASTENERS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Written information; aircraft type structural sections prepared with holes for special rivets and fasteners which include correctly drilled holes, elongated holes, oversized holes, and/or holes which are out of alignment; hi-shear rivets, blind-type rivets and deicer boot fasteners, Riv-nuts or Dill nuts; and prescribed tools for installing each type of rivet or fastener provided.
- Performance:
  The student will inspect the drilled holes and indicate acceptability of each hole, giving reasons for those rejected. He will identify the different types of rivets and fasteners provided and select ten each hi-shear rivets, blind type rivets and deicer-boot fasteners of proper length and diameter for the holes provided. He will install these rivets and fasteners in suitable holes, using appropriate installing tools.
- Standard:
  At least 75 percent of the drilled holes properly identified as to acceptability, correct rivets and fasteners selected, correct installing tools used; and 75 percent of each type of rivets and fasteners properly installed in accordance with information provided.

Key Points	*Feedback*
Methods for checking and detecting acceptable drilled holes for hi-shear and blind type rivets, and deicer fasteners.	What tools may be used to check the drilled holes for acceptability? Describe the effects of elongated or oversized holes on shear type rivets. Will defective holes have equally bad effects on deicer-boot fasteners?
Determining correct size rivet or fastener for a given hole.	How is the length of rivet determined for a specific installation? How is the diameter determined if holes are already drilled? If available rivets are either too small or too large in diameter, what is the proper solution? Where can information be found as to length and diameter of deicer-boot fasteners to be used for a specific job?
Installation tools for hi-shear rivets, blind-type rivets and deicer-boot fasteners.	What special tools are needed for installing hi-shear rivets? Cherry or Huck blind rivets? What special tools are needed for installing deicer-boot fasteners? Why can a better job be done with the designated special tools?

Activities	*Check Items*
	Did the student:
Detect and select acceptable drilled holes for installation of hi-shear, and blind-type rivets.	Use appropriate measuring tools or gauges to check the holes?
Give valid reasons for holes rejected as unacceptable.	Use magnifying glass to visually inspect all holes for roundness and for being drilled vertically?
Measure material thickness and diameter for acceptable holes.	Use proper tools for measuring material thickness and diameter?
Select hi-shear rivets, blind-type rivets, and deicer-boot fasteners of proper sizes for the holes provided.	Properly determine length and diameter of rivets and fasteners to be used?
Install the rivets and fasteners selected.	Use proper installing tools for each type of rivet or fastener?

REMOVE AND REPLACE SPECIAL RIVETS AND FASTENERS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information, aircraft type structural sections with hi-shear and blind-type rivets, deicer-boot, Dzus, Air-loc and Cam-loc fasteners installed; and appropriate tools for removing and replacing such rivets and fasteners.

- **Performance:**
  The student will remove five each of the following types of rivets and fasteners in a manner which permits their replacement with similar rivets or fasteners: hi-shear, Huck and Cherry rivets, Riv-nuts or deicer-boot fasteners, Dzus, Air-loc, and Cam-loc fasteners. He will then replace each removed rivet or fastener with a similar rivet or fastener using appropriate tools.

- **Standard:**
  Removal of at least 75 percent of the special rivets and fasteners correctly accomplished, and 80 percent of the replacement rivets and fasteners correctly selected and installed.

Key Points	*Feedback*
Removal of special rivets.	•What is the procedure for removal of the collar on hi-shear rivets? •How should Cherry and Huck rivets be removed? •What precautions should be taken when removing blind-rivets to avoid damaging the skin around the rivets?
Removal of special fasteners.	•When removing a Riv-nut by drilling, how far should it be drilled? •What determines the size drill to use? •If the stem was left in a blind rivet, what procedure should be followed to remove the rivet?
Replacement of quick disconnect type of fasteners.	•Describe how quick disconnect fasteners such as Dzus or Cam-loc are removed and replaced. •If the area around either part of a quick disconnect fastener has become damaged, how can this be corrected when replacing the fastener?

Activities	*Check Items* Did the student:
Remove hi-shear rivets. a. Cut and remove collars. b. Drive out rivets.	•Cut the collar properly with a chisel? •Remove the collar by unwrapping it? •Use proper tool to drive out the rivet?
Remove blind-type rivets.	•Drive out stems before drilling the rivets? •Remove rivets by drilling through head then pushing out the remaining part of the rivet?
Remove deicer-boot fasteners.	•Drill out the head properly? •Drive out remainder of rivet by using a drive screw or punch?
Remove quick disconnect fasteners.	•Drill out rivets holding locking portion of fastener?
Replace each type of rivet and fastener previously removed.	•Use proper tools and method to install the special rivets and fasteners? •Use same or comparable type of rivet or fastener?

12. HAND FORM, LAYOUT AND BEND SHEET METAL. (EIT = 34 hrs., T = 7 hrs., L/S = 27 hrs.) 4 segments

(UNIT LEVEL 3)

MAKE A JOGGLE IN ALUMINUM SHEET.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information including specifications for a joggle, two sections of a .025 gauge 2024–T3 aluminum alloy, rivets and tools appropriate for making a joggle.

- **Performance:**
  The student will make a joggle in aluminum alloy sheet, using joggle plates and hydraulic press or hammer and joggle block and rivet the joggled sheet to a section of similar sheet material.

- **Standard:**
  Finished joggle will have a flush assembly fit and will meet the specifications provided within .010 inch.

Key Points	*Feedback*
Reasons for using joggles.	•What is the purpose of the joggle? •How are factory joggles produced? •How are joggles formed on flanges and fittings?
Bend allowance and set back for a joggle.	•Why is bend allowance not a major factor in forming joggles in thin sheets? In thick sheets? •When is it necessary to use step shims and taper shims?
Joggle tools.	•How can joggle plates be made to prevent slippage? •Sketch the cross section of joggle dies for a slip roll. •Explain how joggle dies can be made to form a joggle on a flange in a hydraulic press. •How is the die kept from twisting?

Activities	*Check Points*
	Did the student:
Form a joggle in aluminum alloy skin sheet. a. Use hydraulic press and joggle plates. b. Use hammer and joggle block.	•Properly place dies in hydraulic press? •Check for alignment? •Apply proper pressure in forming joggle? •Repeat hammer process until a smooth joggle is formed? •Avoid work hardening by excessive hammer force?
Fit a piece of similar material to joggle and rivet joggle in place.	•Prepare skin properly to fit in joggle? •Cut, deburr, and smooth corners? •Make a flush fit?

PREPARE A LAYOUT FOR A BEND IN AIRCRAFT SHEET METAL.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Written information, reference material on sheet metal bending, a drawing of a sheet metal bend in cross section, a blueprint of an aircraft sheet metal component requiring bending and a section of the sheet metal called for in the blueprint.

- Performance:
  The student will write a brief definition of bend radius, determine and draw in the neutral (axis) line in a cross section drawing of a bend, use a blueprint of an aircraft sheet metal component which requires a bend, to determine the dimensions and prepare a layout on the metal for the bend, taking into consideration the type of metal and the relationship of the metal "grain" to the bend to minimize the possibility of cracking.

- Standard:
  Written definition and marked neutral axis will be correct. Calculated dimensions and layout drawings not more than .030 inch deviation from specifications provided. Relationship of bend to metal "grain" will be correct.

Key Points	*Feedback*
Theory of bend allowance and flat pattern development.	•Define mold line, bend line, mold point, bend allowance and set back. •How are they related? •What is meant by "minimum bend radius"? •What factors effect the minimum bend radius of a metal?
Neutral line (axis of a bend).	•How is the minimum bend radius of a specific metal determined? •What is meant by the "neutral axis" of a bend? •How is this computed? •How is this used to determine amount of material needed and layout dimensions?
Relationship of metal "grain" to possibility of cracking.	•What is meant by "grain" of a sheet of metal? •In which direction relative to the "grain" is a metal less susceptible to cracking in a bend? •What can be done to make a bend less susceptible to cracking when it must be made parallel to the grain?

Activities	*Check Items*
	Did the student:
Interpret a blueprint of an aircraft sheet metal component requiring a bend.	•Determine type of metal and obtain proper bend radius from tables? •Calculate bend allowance properly?

Calculate dimensions of the metal and prepare a layout on the metal with bend lines for the bend.	•Mark bend allowance lines and layout over-all dimensions?
Properly orient the layout relative to the "grain" of the metal.	•Plan the layout so that the bend lines go at right angles to the "grain" of the metal?

LAYOUT AND MAKE BENDS IN SHEET METAL.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
  Written procedures and reference tables for bending sheet metal, sections of various types and thicknesses of sheet metal in various temper conditions, layout and bending tools and equipment.

- **Performance:**
  The student will determine and select a type of sheet metal which requires a large radius for bending. He will calculate and layout dimensions and bend lines for a specified angle of bend and make the bend, using recommended bending techniques. He will select a different type of material which requires a small radius for bending, calculate and layout bend lines for a 130° bend and bend the material to the specified bend, using the minimum bend radius permissible in the tables for the type and thickness of the material used.

- **Standard:**
  All calculations, layouts, and bends will be accurate within .030 inch of the dimensions specified.

Key Points	*Feedback*
Bend characteristics of aircraft type sheet metal. a. Aluminum and aluminum alloys. b. Steel and stainless steel.	•What factors must be considered when determining the bend radius for the various types of aircraft sheet aluminum? •Is the bend radius for ferrous metal generally greater or less than for non-ferrous metals? •How do carbon and stainless steels compare when applying the bend tables for determining bend radius?
Empirical formula.	•What is meant by the empirical formula for calculating bend allowance? •How is this used in direct computation? •How can it be applied by using bend allowance tables?
Set back method of flat pattern development.	•What is the principle of set back or "bend deduction" in determining bend lines? •How is the set back method used when the bend is greater than 90°?
Using a bending brake.	•How is the material located in a bending brake to develop the layout dimension? •How are scratches avoided? •What causes stretching when forming a bend and how is it avoided? •In what temper condition will the greatest "spring back" be experienced?

Activities	*Check Items*
	Did the student:
Select sheet metal that requires a large radius for bending.	•Use specifications to determine minimum bend radii? •Interpret temper condition coded on aluminum sheets?
Develop flat layout pattern for a specified angle of bend.	•Consider the "grain" of the metal in planning the layout? •Apply bend allowance or set back to develop layout dimensions?
Cut material to size	•Use a layout die for marking the layout? •Use a shear for cutting the metal?
Use vertical or cornice bending brake to bend sheets of various tempers at minimum radius of bend.	•Locate material in bending brake properly? •Allow for "spring back" in accomplishing specified bend angle?
Select sheet metal which requires a small bend radius.	•Use bend allowance "empirical formula" or tables?
Layout for a 130° bend.	•Mark bend lines properly?
Using bend brake, make a 130° bend in the selected material.	•Adhere to bend lines when locating material in bending brake? •Check angle of bend after completion?

FORM ALUMINUM PARTS BY BUMPING.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  Written information, blueprints or drawings, flat sheet stock of aluminum in "soft-temper" condition, tools and equipment for forming aluminum by bumping.

- **Performance:**
  The student will interpret blueprints or drawings and form the following parts by bumping: a curved flange, a "U" channel, and a compound curved part, using "V" blocks, crimp and shrink blocks, crimping tool, form blocks, and planishing hammer.

- **Standard:**
  Each part made by bumping will conform to the specification in the blueprint or drawing within .030 inch to all dimensions.

Key Points	*Feedback*
Hand forming techniques:	•When metal is formed, where does thinning of the sheet occur?
a. Use of form blocks.	•How are form blocks used to control the forming process?
b. Bumping or planishing.	•What type of hammers are used for bumping or planishing? •What type of hammer strokes are used? •How is the direction of metal flow controlled during the hammering process?
c. V block and die bumping.	•How are hold down plates used in die bumping? •How can forming sticks be used for die bumping?
d. Shrinking.	•How is a crimping tool and shrink block used to shrink metal in forming a curve?
e. Sandbag bumping.	•What type of hammer is used for sandbag bumping? •What temper condition must heat treatable alloys be in for sandbag bumping? •What will happen if the sand leaks through the bag while being used for bumping?
Forming U channel, tear drop, or blister by bumping.	•How is the material anchored in the form block? •How is work hardening prevented? •What type of hammer and forming stick should be used? •Where is the hammering done first? •What types of blows are used?

Activities	*Check Items*
	Did the student:
Hand form, from blueprints or drawings, a curved flange, a "U" channel, and a compound curved part by use of planishing hammers, forming sticks, "V" blocks, crimp and shrink blocks, crimping tool and form blocks or dies.	•Select proper forming tools and blocks or dies? •Properly anchor the material to be formed? •Work with light blows, in the direction of metal flow? •Use crimping tool properly? •Position form dies and shrink blocks properly to make a compound curve?

13. INSPECT AND REPAIR SHEET METAL STRUCTURES. (EIT = 44 hrs., T = 15 hrs., L/S = 29 hrs.) 10 segments

(UNIT LEVEL 3)

SELECT AND USE TWIST DRILLS AND COUNTERSINKS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  Written information concerning drills and drilling, sets of numbered and lettered twist drills, drill cards, countersinks for rivets and screws, suitable drilling equipment and assorted sheet and structural parts of soft aluminum, aluminum alloys, stainless steel, titanium and magnesium.

- **Performance:**
  The student will select as specified, ten different numbered drills, five different lettered drills, and two types of countersinks. He will use suitable drilling equipment to drill five holes with each selected size of drill. At least five holes will be drilled in each of the following kinds of material: soft aluminum castings and sheet, aluminum alloy thin skin and structural parts, stainless steel and titanium sheet, and cast magnesium. He will countersink five holes each for flush rivets and for flush screws or bolts.

- **Standard:**
  All drilling will be performed in accordance with procedures provided. At least 60 holes will meet specifications and 8 countersunk holes will conform to specified dimensions. 80 percent of holes unmarred around adjacent area.

Key Points	*Feedback*
Drilling characteristics with twist drills.	• How does the point angle differ on drills for soft and hard metals? • How does the drilling RPM differ for soft and hard metals? • Explain some of the causes of an overheated twist drill.
Drilling precautions.	• What type of hole will result from a point ground off center? • Why should the shortest drill that will do the job be selected? • What may result from using a bent drill? • What will be the probable result of too much pressure when drilling?
Selecting drill sizes.	• How can the size of a drill be determined for a specific rivet? • Should the hole be slightly over-size, undersize, or the same size as the rivet shank?
Drilling techniques.	• What is the proper size of center-punched guide mark and pilot hole? • What is deburring and how may it be done? • Why is deburring necessary? • Why does a long curl indicate good drilling technique?
Countersink selection.	• How does the angle of the countersink vary between flush head rivets and flush head screws or bolts? • What determines how deep a hole should be countersunk for a specific rivet or screw? • What procedures may be used to avoid countersinking too deeply?

Activities	*Check Items* Did the student:
Select number and letter twist drills for specified sizes and types of rivets.	• Use a drill card to assist in selecting correct sizes? • Check point condition and angle before using drill?
Drill holes in soft and hard metal, in thin and thick sheets and in structural type of parts, including aluminum, stainless steel, titanium and magnesium.	• Determine drill speed for each type of metal? • Select proper point angle for the type of metal to be drilled? • Center punch properly? • Use pilot hole when required? • Drill vertically and with proper pressure? • Deburr holes after drilling?
Countersink holes for flush head rivets and screws or bolts.	• Select proper angle and diameter countersink for each job? • Determine specified diameter for countersink? • Use a technique which resulted in the correct depth and diameter of countersink?

SELECT AND USE HAND FILES FOR SOFT METALS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  Metal working information, a variety of metal working files, samples of aluminum and magnesium, a work bench and vise or clamps.
- **Performance:**
  The student will select suitable hand files for soft metals and use them to file down and finish aluminum and magnesium to specified dimensions.
- **Standard:**
  Filing techniques will be in conformance with information provided. Completed jobs will meet dimensions within .010 inch and will have a smooth finish.

Key Points	*Feedback*
File types and designs.	• What are double cut and single cut files?

	What type of file is designed for use on aluminum and magnesium? Will the same type of file be suitable for heat treated aluminum alloys?
Proper use of files for soft metals.	Why should the file be used in only one direction? What amount and type of pressure should be put on the file as it is used? Why should a file always be used with a handle on it? How should a file be held with respect to the surface to be filed?
Cleaning files.	How should a file be cleaned and how often? Why must metal clogging be cleaned out at once whenever it occurs?

Activities	*Check Items*
	Did the student:
Select proper files for use on aluminum and magnesium. Use coarse and fine files to file down and finish surfaces on aluminum and magnesium sheet and structural parts to specified dimensions.	Anchor work securely in vise or with clamps? Hold file with both hands, one hand at each end? Move file in cutting direction only? Use finer file for finishing? Use smooth, even strokes? Clean file regularly to prevent or remove clogging?

REPAIR SHALLOW SCRATCHES IN SHEET METAL.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information on minor repairs of sheet metal, a sample of aluminum or magnesium aircraft skin with one or more shallow scratches, and burnishing tools.

- **Performance:**
  The student will identify scratches repairable by burnishing and burnish one or more scratches in sheet metal of the type used for aircraft skin.

- **Standard:**
  Burnishing will be accomplished in accordance with procedures in the information provided.

Key Points	*Feedback*
Repairs allowable by burnishing.	What is meant by shallow scratches? What reasons are there for doing anything about shallow scratches? What purpose does burnishing serve?
Burnishing techniques and materials.	What tools and materials may be used for burnishing scratched areas? What precautions should be taken? How should a mechanic determine whether alclad or magnesium airplane skin should be burnished when scratched?
Other scratch repair techniques.	How can skin scratches be filled and covered? In what areas of an airplane may this be preferable?

Activities	*Check Items*
	Did the student:
Burnish or polish shallow scratches in samples of sheet metal as used in airplane skin.	Use proper materials and tools? Observe precautions against excessive burnishing? Limit depth of burnish to depth of scratch? Burnish in a manner that tended to fill the scratch?

REPAIR A SLIGHTLY OVERSIZE HOLE BY REAMING FOR NEXT LARGER SIZE RIVET.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  Written information, rivet hole size tables, an aircraft part with a hole that is slightly oversize after rivet removal, reaming and hole measuring tools.

- **Performance:**
  The student will determine the next larger size rivet and what diameter hole it requires, ream the hole, and obtain, by measurement, a hole of correct size for the rivet selected.

- **Standard:**
  The hole will be true round and vertical, and meet specified diameter within 10 percent.

Key Points	*Feedback*
Measurement of holes.	• What tool can be used to measure the diameter of a hole? • How can the degree of roundness be determined? • How can it be checked for being vertical?
Reaming techniques.	• What type of reamer may be used with either a power drill or by hand? • What type must be hand operated only? What depth of cut should be taken with each application of the reamer? • What precautions should be taken when reaming?
Limitations on enlargement of holes.	• What parts of an airplane are restricted on hole enlargement? • What effect does the spacing between holes or to edges, have on the enlargement permitted? • How much oversize is necessary when replacing a standard rivet with a larger pull-type rivet?

Activities	*Check Items*
	Did the student:
Determine hole size for a selected replacement rivet.	• Use rivet tables to determine size hole required for the size and type of rivet selected?
Enlarge a slightly oversize hole by reaming.	• Use proper reaming tools and speeds?
Check hole to make sure it is round and vertical and meets diameter specifications.	• Perform hole measurement accurately and correctly?

PREPARE DISSIMILAR METALS FOR ASSEMBLY.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:
  Written information, AC 43.13–1 or equivalent publication, samples of several dissimilar metals used in aircraft assemblies, materials and equipment for applying corrosion protection coatings on the metal samples provided.

- Performance:
  The student will determine the type of corrosion protection required for assembly of five different dissimilar pairs of aircraft type metals and list the type of coating to be applied to each pair selected. He will apply coatings as specified on two pairs of the selected metals which require corrosion treatment.

- Standard:
  Determine correct corrosion protection, listing coatings to be used for at least four pairs and apply corrosion protection on two pairs of dissimilar metals in accordance with specifications.

Key Points	*Feedback*
Causes of dissimilar metals corrosion.	• What provides the electrolyte path for dissimilar metal corrosion? • Explain why only one surface corrodes from the electrolytic action? • What determines the degree of the corrosion attack?
Groupings of metals by galvanic activity level and compatibility.	• Explain why two different metals in the same group may be used together without danger of intersurface corrosion? • Can all aluminum alloys be considered as similar?
Protective coatings.	• Name some corrosion protection measures taken before fabrication of metal parts.
a. Anodizing and related processes.	• What types of coating or treatment can be used in line work assembly of dissimilar metals?
b. Zinc chromate.	• What is the recommended thickness of a zinc chromate coating? • Why isn't a thick coating advisable?
c. Other protective coatings.	• What methods other than zinc chromate are used to prevent dissimilar metal corrosion? • Explain dope proofing and when it is needed. • Explain why the surface must be extremely clean before any type of protection is applied.

Activities	*Check Items*
	Did the student:
Determine the type of corrosion protection needed for each of several different pairs of dissimilar metals.	•Use AC 43.13–1 or equivalent publication to determine needed protection measures for each pair?
Apply corrosion protection coatings on two different types of dissimilar metals.	•Thoroughly clean both surfaces before applying protective coatings? •Apply coating to all mating surfaces?

DESCRIBE LOADS IN FUSELAGE AND WING STRUCTURES AND TYPES OF OVERLOAD FAILURE.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information, drawings of aircraft, showing structure of monocoque and semimonocoque fuselages, drawings showing construction of a cantilever wing, and descriptions of bearing and shear failures as related to sheet metal structure.

- **Performance:**
  The student will show by arrows and labels, which members, in normal flight, carry primary bending and torsional loads in a monocoque and a semimonocoque fuselage, and the tension and compression loads imposed upon the spars in a cantilever wing structure. From a written description of a bearing failure and a shear failure, each at a riveted area in a sheet metal structure, the student will draw a sketch showing by arrows the applied loads and by breakage lines, the type of breakage which occurs in each type of failure.

- **Standard:**
  At least 70 percent of the loads will be correctly indicated and breakage lines will be drawn correctly.

Key Points	*Feedback*
Monocoque and semimonocoque fuselage structures.	•What types of materials may be used in these two types of fuselage? •What absorbs the loads of stress in each type? •What is the difference between stringers, longerons and skin stiffeners?
Use of bulkheads.	•What is a bulkhead, and what purposes does a bulkhead serve? •What means of material strengthening is used in bulkhead fabrication? •Why is rivet size and pattern critical in relation to bulkheads?
Loads acting on monocoque and semimonocoque fuselages.	•By what part of the structure are bending loads acting on a fuselage absorbed? •What imposes tension loads and by what part of the structure are they absorbed?
Additional loads imposed by pressurization.	•What happens to tension loads when the fuselage is pressurized? •By what part of the structure are compression loads absorbed? •How much negative pressurization can be tolerated?
Shear and bearing loads.	•Shear loads are the result of what, and by what part of the structure are they absorbed? •What effect could the use of oversize rivets have on skin sheets, bulkheads, and stringer flanges?
Full cantilever and semicantilever wing structures.	•How can a full cantilever wing structure be recognized? •With which type are external lift struts used? •What supports the bending loads of each type?
Loads acting on the wing and spar structure.	•What loads are imposed upon the wing in flight? •How much of the wing loads are absorbed by the spar or spars? •What are the effects and importance of fuel loads in cantilever wings?
Detection of structural failure.	•How can partially sheared rivets be detected? •How is bearing failure recognized? •What is the cause? •Where can information be found to assist in interpreting structural damage or failure? •Where can repair procedures usually be found?

Activities	*Check Items*
	Did the student:
On drawings of monocoque and semi-monocoque fuselage structures, draw arrows to show direction and location of bending and torsional loads and label each.	•Identify each drawing correctly? •Show correct direction for each type of load?
On drawings of cantilever wing structure, show by arrows, the direction and location of tension and compression loads and label each.	•Show the direction of loads with respect to the spar or spars in the wing? •Correctly label each load?
Draw a sketch of a bearing failure and of a shear failure, showing by arrows the applied loads and by breakage lines the type of breakage in each failure, with labels explaining each sketch.	•Show the failures as related to one or more rivets? •Show the bearing breakage as being in one layer of skin? •Show the shear failure as being in the rivet or rivets?

REPAIRS TO STRESSED-SKIN AIRPLANE WINGS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information, AC 43.13–1 or equivalent publication, a section or a mock-up of a stressed-skin airplane wing, tools and materials for making stressed-skin repairs.

- **Performance:**
  The student will perform repairs for the following real or introduced damage: a hole in a stressed-skin metal wing, a section of damaged skin (using a single-lap sheet splice), damaged stringers on the lower surface of a stressed-skin metal wing. He will determine the correct rivet layout and spacing for each repair and perform the dimpling process in at least one of the repairs.

- **Standard:**
  All repairs will be of correct type and gauge metal and will be laid out in accordance with specifications in the publication provided, and at least 75 percent of the rivets will conform to spacing and riveting technique.

Key Points	*Feedback*
Structural repair specifications.	•Which is preferable to use, the manufacturer's repair manual or FAA specifications? •What type of metal is to be used for a stressed-skin repair? •What is the importance of preparing a layout for the repair first?
Repairing holes.	•How does the diameter of the hole affect the size of a patch? •What types of patches may be used for holes in stressed skin? •May a plug patch overlap a structural member?
Patching damaged skin.	•How is a repair made when the damage is extensive or across a structural member? •Where must the repair seams lie and how are the holes planned? •What should be done to cracks to prevent them from extending?
Repairing damaged stringers on lower surface of stressed-skin wing.	•What kind of repair is used for damaged stringers? •Which requires the greater number of rivets, an upper or lower surface stringer repair? •Can bolts be used for any part of a stringer repair?
Dimpling for flush rivets.	•In what types of material is dimpling preferable to countersinking? •How are the dimples made to match smoothly in the skin and the patch plate?

Activities	*Check Items*
	Did the student:
Perform the following repairs to stressed skin wing sections: Install a patch for a hole in the skin. Repair slight damage to stressed skin.	•Determine repairs specified either in FAA publication or manufacturer's repair manual? •Make a layout plan for each repair? •Trim out damaged skin properly? •Stop drill cracks to stop any extension?

Repair damaged stringers on the lower surface of a stressed skin wing.	•Prepare and install adequate stringer splices? •Dimple all skin holes and all matching holes in the patch plate?
Perform dimpling and install flush rivets in one patch.	•Perform dimpling in a manner that resulted in a smooth surface across the flush rivet heads when installed? •Use proper gun and bucking technique for each kind of rivet?

REPAIR AIRCRAFT STRUCTURAL UNITS BUILT FROM SHEET METAL.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  Written information, AC 43.13–1 or equivalent publication, aircraft sheet metal structural members with failed sections (such as spars or engine mounts), tools, rivets and materials for sheet metal repair.

- Performance:
  The student will repair two damaged sections in aircraft sheet metal structural units. He will determine the type and size of repair splice or patch for each damaged section, plan and layout the rivet patterns, select proper number and types of rivets required and use proper riveting techniques in making the repairs.

- Standard:
  Both repairs will conform to the specifications as to size of patch, type and gauge of metal used and rivet layout. At least 75 percent of the rivets installed will meet specifications.

Key Points	*Feedback*
Typical damages to structures built of sheet metal.	•Where is damage most likely to occur in spars made from sheet metal? •In engine mounts built of sheet metal, what areas are most likely to fail or show damage? •How can bearing failure in sheet metal structures be detected? •Where will evidence of shear failure be found?
Determine type of repair to be made.	•Where can references be found for repairs to be made for a specified area? •If approved references are not available, what should be done?
Strength and material requirements.	•What is the strength criteria? •How does the material to be repaired effect the type of material selected for the repair? •What consideration is given to rivet area when computing strength requirements?
Rivet requirements and spacing.	•Where can rivet specifications for sheet metal structural repairs be found? •Can Cherry bulb rivets be used in place of standard rivets? •How much oversize is necessary if Cherry bulb rivets are used?

Activities	*Check Items*
	Did the student:
Evaluate damage and determine needed repairs for two sheet metal structure failures.	•Inspect failed sections and adjacent areas to determine type of failure? •Use manufacturer's or FAA publication for references?
Determine the shape and size of repair needed.	•Determine necessary bending radii?
Select proper type and gauge of metal for the repair.	•Calculate needed thickness for repair material with consideration for rivet area? •Round off all sharp corners?
Draw repair layout with proper rivet pattern and spacing.	•Use proper bending techniques? •Use proper drill and countersink techniques?
Cut out repair patch or splice and make any necessary bends.	•Use proper riveting technique?
Drill holes and countersink where necessary.	
Install repair patch or splice.	

DETERMINE CONDITION OF STRESSED SKIN STRUCTURE WHICH HAS BEEN CRITICALLY LOADED.

(SEGMENT I, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information and a section of a stressed skin metal aircraft structure which is known to have been critically loaded and which has several overload indications.

- **Performance:**
  The student will inspect the skin, rivets, and structural members for evidence of damage. He will list any popped or sheared rivets, wrinkled or distorted skin areas, misaligned or cracked structural members and any other evidences of overload.

- **Standard:**
  At least 75 percent of all visible indications of damage will be listed correctly.

Key Points	*Feedback*
Indications of overload.	•What are the most easily seen indications of overload to a stressed skin structure?
a. By condition of stressed skin.	•Will stressed skin return to shape after once being overstressed by an overload? •What is meant by the term "oil canning" when applied to stressed skin sections?
b. By condition of rivets.	•What is meant by a "popped" rivet? •How does a popped rivet differ from a sheared rivet? •What is the indication of "tipped" rivets? •What type of strain causes tipped rivets?
c. By misalignment of rivets or structural members.	•What does a misalignment of rivets indicate? •What does a misalignment of structural members indicate?
d. By cracks in skin leading away from rivets or in bends.	•What do cracks leading away from rivets indicate? •What do cracks in the radii of bends indicate? •May cracks, which penetrate only the clad surface of a bend, be ignored?

Activities	*Check Items*
	Did the student:
Inspect a stressed skin aircraft structure section which is known to have been critically loaded.	•Look for wrinkled and distorted skin areas? •Look for misaligned structural members? Misaligned rivets?
Check condition of skin, structural members, rivets and riveted areas.	•Look for cracks at rivets or in bends? •Look for popped or sheared rivets? Tipped rivets?

CONSTRUCT A WATERTIGHT JOINT.

(SEGMENT J, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information, sheet aluminum alloy, sealer, and appropriate tools and equipment for constructing a watertight joint.

- **Performance:**
  The student will layout, cut, and drill two sections of aluminum alloy for a joint which is to be made watertight. Sealant will be applied and the joint will be constructed by riveting the two sections together in a watertight joint. Test will be made to assure that the joint will not leak under water pressures.

- **Standard:**
  Rivet pattern will conform to specifications in FAA publications, rivets will be properly installed, and water will be contained by the joint without leakage.

Key Points	*Feedback*
Edge distance in watertight joints Rivet pattern and holes.	•Should the edge distance in a watertight joint be greater than in a normal joint? •Compare rivet spacing for a watertight and normal joint? •Should the holes be oversize or close fit?
Sealant for watertight joints.	•What sealant would be used if the joint was for a seaplane float? •Would the same sealant be used for repair of a potable water tank? •When is the sealant applied?
Testing for leaks.	•How soon after completion may a joint be tested? •Suggest a method of testing for leakage.

Activities	*Check Items*
	Did the student:
Layout a pattern for a watertight joint in two sections of aluminum alloy.	•Use proper edge distance? •Use proper rivet spacing?

Drill holes, apply sealant and install rivets.	**•Drill holes properly for trueness and fit?** **•Make sure both surfaces are smooth and clean before applying sealant?** **•Apply sealant evenly to both surfaces?** **•Install rivets with adequate set and tightness?**
Test joint for leakage.	**•Follow sealant instructions as to time to wait before testing?** **•Test watertightness of the joint?**

14. INSPECT BONDED STRUCTURES. (EIT = 9 hrs., T = 4 hrs., L/S = 5 hrs.) 2 segments

(UNIT LEVEL 2)

INSPECT AND REPAIR METAL SANDWICH STRUCTURES.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information and repair procedures, drawings or photos of aircraft metal sandwich materials, questions with multiple choice answers with reference to bonded aircraft structures.

- **Performance:**
  The student will select answers for ten questions concerning types of bonded metal aircraft material, purposes and reasons for use of metal sandwich panels in high-speed aircraft construction, and the use of metallic "ring" test to inspect for delamination damage of bonded structures.

- **Standard:**
  Select correct answers for at least seven questions.

Key Points	*Feedback*
Construction of metal sandwich structures.	**•What types of construction may be used in metal sandwich structures?** **•What are the main components of honeycomb structures?** **•What materials are used?** **•How are the materials bonded together?**
Construction of honeycomb structures.	**•Why are honeycomb structures used in the modern airplane?** **•What nomenclature is applied to the main components of honeycomb structures?**
Inspection of bonded structure.	**•What is the purpose of the metallic ring test?** **•How is it made?** **•What type of damage is it intended to detect?** **•How can damage from moisture effects be evaluated?**
Removal of damaged material.	**•Where are instructions for making repairs to a honeycomb structure found?** **•When delamination is detected, how is the damaged material removed?**
Repair procedures.	**•What tools would be used?** **•What is used to clean the damaged area prior to repair? How clean should it be?**
Characteristics of a good repair.	**•What constitutes a good repair of metal sandwich structure?** **•How can the repaired area be inspected or tested for acceptability?**
Safety precautions.	**•What safety hazards exist while repairs are being made to a honeycomb structure?**

EVALUATE DAMAGE TO BONDED STRUCTURE AND DETERMINE TYPE OF REPAIR NEEDED.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information and repair specifications, and a section of aircraft bonded structure which has a damaged area.

- **Performance:**
  The student will inspect the damaged bonded structure, evaluate the extent of the damage, and prepare a work description for the type of repair needed.

- **Standard:**
  Evaluation and description of repairs conform to specification for at least 75 percent of detectable damage.

Key Points	*Feedback*
Visual inspection for evaluation of damage.	•What evidences of internal damage may appear in the metal surface layer? •Where are skin cracks likely to occur? •What would a blister indicate?
Mechanical tests for damage evaluation.	•How is a tapping inspection made? •What is the nature of the sound if bonding is satisfactory? If delamination has occurred? •How is a spur wheel test conducted?
Work description for repairs.	•Where can procedures for repairs to bonded structures be found? •What should be included in a work description for repairs?

Activities	*Check Items*
	Did the student:
Inspect a section of aircraft bonded structure which has known damage.	•Visually inspect for cracks or blisters? •Use a coin or other object for making a tapping test?
By visual inspection and mechanical tests, evaluate the type and extent of the damage.	•Outline the detected damage area to assist in planning repairs? •State method of repairing and extent to be included?
Write a work description of the repairs which should be accomplished.	•State tools and repair materials needed?

15. INSPECT AND REPAIR PLASTICS, HONEYCOMB AND LAMINATED STRUCTURES.

(EIT = 11 hrs., T = 3 hrs., L/S = 8 hrs.)
2 segments

(UNIT LEVEL 2)

IDENTIFY AND REPAIR PLASTIC, FIBER AND FIBERGLASS AIRCRAFT MATERIALS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

• Given:
Written information, manufacturer's reference material and samples of different types of plastic, fiber, and fiberglass aircraft structural and enclosure material.

• Performance:
The student will identify and label ten samples of different plastics, fiber, and fiberglass, including honeycomb and laminated fiberglass structure materials. He will answer fifteen questions concerning protection of plastics while being handled or worked, cleaning and polishing of plastics and fiberglass, methods of painting or surface coating plastics and fiberglass, and repair methods for plastic, fiber, and fiberglass aircraft structures.

• Standard:
Correct labels for seven samples and correct answers for ten questions.

Key Points	*Feedback*
Basic types of plastics for aircraft applications.	•What are some primary differences between acrylic and acetate plastics?
a. Acrylic plastics.	•Name several uses for acrylic plastics in aircraft. •What precautions must be taken when cleaning clear acrylic plastic? •How can acrylic plastic be identified?
b. Cellulose acetate plastics.	•What are some aircraft uses for acetate plastic? •How can acetate plastic be identified? •What precautions must be taken when cleaning acetate plastic?
Repairing plastics.	•What are the limitations to repairs of plastic structures? •How can temporary repairs be made for cracks in plastics? •Is the same type of cement applicable to both kinds of plastic?
Use of fiber in aircraft.	•Why is the use of fiber in aircraft structure rather limited?
Fiberglass types and uses.	•Describe the difference between moulded and laminated fiberglass. •What materials may be used in fiberglass honeycomb panels for the honeycomb? •Why is fiberglass use rapidly increasing in aircraft?

Repairing fiberglass structures and panels.	•How are damaged areas in fiberglass structures or panels prepared for repair? •How much of the honeycomb material must be removed to repair a dented or crushed area? •What type of repair should be made for such a damaged area? •How is a damaged area of laminated or moulded fiberglass repaired? •What degree of cleanliness is required when making a fiberglass repair?

Activities	*Check Items* Did the student:
Identify and label ten samples of plastic, fiber, and fiberglass in moulded, laminated, or honeycomb panel forms.	•Check the edge color to determine whether plastic was acrylic or acetate? •Differentiate between fiber and fiberglass? •Recognize the difference between moulded and laminated fiberglass?

REPAIR DAMAGED AREAS IN FIBERGLASS AIRCRAFT STRUCTURES.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given

Written information, and procedures for repair of fiberglass structures, sections of moulded and laminated fiberglass honeycomb structure with a punctured or crushed area.

- Performance:

The student will evaluate repairs needed, prepare each damaged area for repair, and make the repairs specified for one section each of moulded fiberglass, laminated fiberglass and fiberglass honeycomb aircraft structure. He will finish each repaired area by removing excess material, blending the repair into the surrounding area and smoothing to match the original surface.

- Standard:

At least 2 of the 3 repaired areas will conform to return-to-service standards as specified in the procedures provided.

Key Points	*Feedback*
Evaluation of repairs needed.	•What is a criteria for determining whether a structure should be repaired or replaced? •Where can repair specifications be found for a specific section of aircraft fiberglass structure? •What are some determining factors for a temporary or permanent repair?
Preparation of damaged area for repair.	•How much of the damaged area should be removed? •What tools may be used to clean out damaged fiberglass? •What precautions should be taken while cutting or grinding fiberglass? •How clean must the area be before patching?
Repairing the prepared area.	•What type of repair is most commonly used for moulded or laminated fiberglass? •How may a patch for fiberglass honeycomb structure be made? •In mixing epoxy, how closely must the mixing instructions be adhered to? •How critical is the curing process?
Finishing repaired areas in fiberglass structures.	•How can excess material be removed from the patched area? •What tools and methods may be used to smooth the repaired area and blend it into the surrounding surface? •How may a matching polish be obtained?

Activities	*Check Items* Did the student:
Evaluate damaged areas in moulded and laminated fiberglass structure and in fiberglass honeycomb structure to determine repairs needed.	•Inspect each damaged area for extent and depth of the damage? •Obtain repair methods and procedures from the manufacturer's repair manual or other reference material?
Remove all damaged material from each damaged area.	•Use proper tools and work procedures?

	•Take adequate precautions against fiberglass dust, toxic fumes and skin irritants?
Make repair patches suitable for the type of structure being repaired, using epoxy cements, fiberglass cloth or laminate and filling materials.	•Adhere to instructions while mixing epoxies? •Build up laminate repairs properly with attention to criss-crossing fibers? •Use suitable power or hand tools to remove excess patch material?
Dress off any excess fiberglass and epoxy to level of surrounding material.	•Use proper type and direction of strokes in blending and polishing?
Blend edges of the patch into surrounding surface and polish the patched and adjacent area to a luster equal to the original material.	•Use polishing materials as specified in manual or reference material provided?

16. INSPECT, CHECK, SERVICE AND REPAIR WINDOWS, DOORS, AND INTERIOR FURNISHINGS. (EIT = 12 hrs., T = 3 hrs., L/S = 9 hrs.)

3 segments

(UNIT LEVEL 2)

RECOGNIZE DISTINGUISHING CHARACTERISTICS OF TRANSPARENT PLASTIC AND PLATE GLASS ENCLOSURES.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Written information, samples of transparent plastic and plate glass aircraft enclosures.

- Performance:
  The student will select samples of transparent aircraft enclosures made of acrylic plastic, acetate plastic, solid tempered plate glass, shatter-proof laminate plate glass, and plate glass with thermal anti-icing plastic layer, list type of material and distinguishing characteristics for each.

- Standard:
  Correctly list type for at least four types of material and list distinguishing characteristics for three types.

Key Points	*Feedback*
Kinds of transparent material used in aircraft enclosures.	•Which two types of plastics are commonly used for transparent aircraft enclosures? •Where is plate glass used for aircraft enclosures? •What methods are used to strengthen plate glass windows?
Distinguishing characteristics of transparent materials used for aircraft enclosures.	•Compare plastic and glass for ease of cutting, resistance to scratching, strength and weight. •Why is transparent plastic critical as to what cleaning agents are used on it? •How can plate glass be made safe from shattering? •How can electrical anti-icing be incorporated into a plate glass or plastic enclosure?

Activities	*Check Items*
	Did the student:
Select sample transparent aircraft enclosures which are made of flator curved acrylic plastic, acetate plastic, solid tempered plate glass, shatterproof plate glass, and plate glass with an anti-icing layer incorporated.	•Identify samples by visual inspection of the edge cross section? •Use weight and hardness as distinguishing characteristics? •Use color as a distinguishing characteristic?
List each sample by type of material and distinguishing characteristics.	•Use electrical terminals to distinguish plate glass with anti-icing incorporated?

CLEAN, PROTECT, REPAIR AND SECURE TRANSPARENT PLASTIC AIRCRAFT ENCLOSURES.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Written information, AC 43.13–1 or equivalent publication, transparent plastic enclosure materials, and plastic windows with surface scratches, cleaning, scratch removing, and installation equipment and materials.

- Performance:
  The student will clean plastic windows, remove shallow scratches and surface crazing from transparent plastic enclosures, protect plastic enclosure material during handling, repairing and storage, and secure plastic enclosures in aircraft structures.

- **Standards:**
  Conformance to procedures given in the manufacturer's manual or in AC 43.13-1 or equivalent publication.

Key Points	*Feedback*
Cleaning plastic	• What type of cleaner *must* be used? • What qualities *must* it have? • What should be used to wipe plastics and what precautions should be taken? • What is a safe method of polishing plastics?
Removing shallow scratches and surface crazing.	• What compounds may be used to remove minor scratches or surface crazing? • What methods are recommended for buffing or polishing out scratches? • Why should precautions be taken to avoid excessive heating? • What should be done if the scratches or crazing prove to be too deep for easy removal?
Protecting transparent enclosure materials for handling, repairing or storage.	• *What should be used to* protect both surfaces of transparent plastic enclosures until ready for installation? • What should be done to protect the area not being worked on during repairs of plastic enclosures?
Securing plastic windows and windshields in aircraft structure.	• What methods are used for mounting plastic windows and windshields in basic aircraft structures?
a. Use of frames between plastic and structure.	• Compare the expansion rates of plastic enclosures with the metal surrounding them.
b. Securing by metal channels.	• When windshields or windows are mounted in metal channels, how much allowance should be made for expansion?
c. Securing by bolts.	• When bolts are used to secure plastic windows, how large should the holes be? How tight should the bolts be? • Under what conditions is it permissible to replace the bolts with rivets?
d. Securing by rivets.	• What must be used with the rivets to avoid excessive pressure on the plastic when the rivets are set? • What size holes should be provided for securing by rivets?

Activities	*Check Items*
	Did the student:
Clean transparent plastic enclosures such as aircraft windows and windshields.	• Use only approved materials for cleaning? • Use plenty of water? • Use soft cloth or sponge? • Avoid polishing or buffing to a degree that would cause heat generation in the plastic?
Remove shallow scratches or surface crazing in transparent plastic enclosure material.	• Use manufacturer's manual to obtain repair information? • Use approved mixture or compound and proper buffing RPM? • Use wax or approved polishing material to polish repaired area?
Protect transparent plastic enclosures for handling, repairing and storage.	• Cover both surfaces with non-scratching paper? • Tape covering in place? • Mark identity of contents and caution to handle with care and store on edge, if for storage?
Secure plastic windows or windshields to aircraft structures.	• Determine specified method of securing and hardware to be used from manufacturer's manual? • Use proper procedures in securing plastic to frame? • Make allowance for greater expansion of plastic than of the metal?

INSPECT AND CHECK PRESSURE SEAL DOORS AND WINDOWS, SEAT RECLINE MECHANISMS AND SAFETY BELT INSTALLATIONS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A written check list, manufacturer's manual, FAA Technical Standard Orders, a pressurized aircraft section or mock-up with door and window installations, a seat with recline mechanism and a safety belt installation.

- Performance:
  The student will inspect and check the pressure seal and latching mechanism in an externally opening entrance door for a pressurized aircraft, remove, inspect and replace a pressure seal window in a window frame or escape hatch of a pressurized aircraft, inspect, check and adjust as needed, the reclining mechanism of an aircraft reclining seat with automatic return and inspect and check a safety belt installation for being acceptable to FAA standards.

- Standards:
  All items will be correctly judged; doors, windows and seat mechanisms will operate as designed. The safety belt will be correctly installed, identified and the condition of all equipment will be noted on the check sheet.

Key Points	*Feedback*
Source of information.	• Where is information on doors, windows and cabin equipment found?
Pressure seal doors.	• How many pounds of pressure does a 9 square foot door have to withstand at 2.5 PSI pressurization? • What type of locking mechanism is usually used in externally opening pressure seal doors? • How critical is a slight air leak at the door seal? • How critical is it that the latch pins engage fully?
Pressure seal windows.	• Why is the window size limited in pressurized aircraft? • How are the windows secured to the frames? • How much should the securing bolts be tightened? • What is provided to prevent pressure leakage?
Reclining seat mechanisms.	• Why is an automatic return desirable in reclining type cabin seats? • What is usually provided to prevent too rapid return? • Why is it important that the reclining mechanism stay locked when not intentionally released?
Safety belt installation.	• To what should the safety belt be anchored? • Where can specifications for safety belt installations be found? • What indication can be found as to whether a safety belt is approved? • What checks must be made to determine whether a safety belt meets return-to-flight standards?

Activities	*Check Items* Did the student:
Inspect and check operation of a pressure seal door.	• Obtain manufacturer's instructions on the operation and checking of the door latching mechanism?
Check operation of the latching mechanism.	• Remove viewing plates or covers and inspect operation of latching pins? • Make sure the door latches and releases freely and properly?
Remove, inspect, and replace a pressure seal window in a window section or escape hatch.	• Remove all securing bolts, to check condition of window edges? • Replace pressure seals? • Install all securing bolts by tightening firmly then backing off one full turn? • Clean both surfaces of the window with approved cleaning materials?
Inspect, check, and adjust as needed, a reclining seat mechanism.	• Remove covers to permit observation of the recline mechanism while operating? • Check for ease of release of recline latch?
Check the release latch return spring, damping cylinder and position lock.	• Check for firmness of lock when engaged?
Operate seat back through its full range of recline and check for proper return.	• Check for full range of movement of seat back? • Check for proper return spring tension? • Check return time to make sure damping is satisfactory?
Inspect and check operation of safety belt latch and slide, and attachment to floor.	• Check condition of belt? • Check holding strength of buckle?

- **Check ease of length adjustment when released?**
- **Check for adequate strength of floor attachments?**

17. SOLDER, BRAZE AND ARC-WELD STEEL.

(EIT = 32½ hrs., T = 7 hrs., L/S = 25½ hrs.)
3 segments

(UNIT LEVEL 2)

PREPARATION AND PRECAUTIONS BEFORE SOLDERING, BRAZING AND WELDING.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
Written technical information, AC 43.13–1 or equivalent publications, and multiple choice questions concerning preparations and precautions before soldering, brazing and welding.

- Performance:
The student will select answers for ten questions concerning the preparation of metal for soldering, brazing and welding, preheating prior to welding and the precautions regarding welding over previously brazed or soldered joints.

- Standard:
Select correct answers for at least eight questions.

Key Points	*Feedback*
Preparing metal for: a. Soldering.	•What is the process of cleaning before soldering? •What kinds of metal require an application of flux before soldering is started?
b. Brazing.	•What cleaning is required to prepare metal for brazing? •When is it necessary to remove metal in the area to be brazed? •On what metals is it helpful to apply flux before brazing?
c. Welding.	•Why must all surface area to be welded be thoroughly cleaned to bare metal? •What method may be used to remove any soldered or brazed spots within the area to be welded? •When cleaning with a wire brush for welding, why should a brush of a dissimilar metal be avoided?
Positioning of parts for soldering, brazing and welding.	•Why is it important to plan ahead and consider size, position and angle for all soldered, brazed or welded joints? •What is the importance of holding the elements of a joint firmly in position during soldering, brazing or welding? •When welding, what provision should be made to avoid misalignment due to expansion and contraction?
Determining whether to solder, braze or weld.	•What factors must be considered when determining whether a joint should be soldered, brazed or welded? •Explain how the decision will be influenced by whether the work is to be done in the shop or on the airplane.
Precautions to be taken prior to soldering, brazing or welding.	•What precautions should be taken to avoid damage to surrounding materials or objects? •What precautions should be taken with regard to combustible materials in the area? •What personal protection should be considered, such as goggles or face masks and protective clothing?

SOLDER ELECTRICAL CONNECTIONS AND MAKE LAP-JOINTS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
Written information pertaining to soldering, samples of aircraft electrical wire, cable, and solder type connectors; scraps of brass shim material, tinned steel, stainless steel, and soldering equipment.

- Performance:
The student will solder electrical wires or cables to solder type connectors, sweat-solder lap-joints of brass, tinned steel and stainless steel.

- Standard:
Wires and cables will be soldered to connectors in compliance with connectors manufacturer's specifications and lap-joints will each have at least 70 percent indicated surface adhesion when torn apart.

Key Points	*Feedback*
Definitions of brazing and soldering.	•What is the difference between adhesion and fusion? •What is the difference between hard and soft solder? •How does silver solder differ from either soft or hard solder?
Composition of solders.	•What is meant by eutectic solder? •Explain the differences between 50/50, 40/60 and 60/40 solder. •What type of solder has a 70/30 mix? •What is the usual composition of silver solder?
Soldering fluxes.	•Why is a flux required when soldering hard or soft solder? •What type of solder flux is usually used for electrical soldering? •What is the difference between resin core and acid core solder? •For what purposes is acid core solder used?
Tools and equipment for soldering.	•List the tools and equipment used for soft soldering; for hard soldering.
Soft (lead/tin) soldering.	•What kind of solder is used to soft solder a joint? •When is the use of soft soldering acceptable? •Why should the use of excessive solder be avoided when soldering electrical wiring? •What is meant by sweat soldering? •Discuss the safety precautions to be observed when soldering. •What is meant by continuity in a soldering joint? •What factors determine that a soldered joint is acceptable?
Hard soldering.	•Describe the difference between hard and soft solder. •Describe hard soldering and how it is done. •What flux is used? •Name several hard soldering alloys.
Silver soldering.	•Name some of the materials commonly joined by silver soldering. •Describe the advantages and disadvantages of the silver solder process. •Name the type of flux acceptable for soldering stainless steel, copper, Monel, brass.
Avoiding corrosion after-effects from fluxes.	•What dangerous after-effect must be prevented when using fluxes? •How are all traces of flux removed from soldered joints?

Activities	*Check Items*
	Did the student:
Solder aircraft electrical wires and cable to solder type connectors.	•Strip and clean wires properly? •Use resin core solder or resin flux with solid soft solder? •Tin each wire and each connector cup before soldering? •Use only enough solder to make a filled junction? •Use just enough heat to cause full penetration of the solder within each junction? •Avoid moving each junction until solder had set?
Prepare sections of brass shim stock, tinned sheet steel and stainless sheet for lap joint soldering.	•Clean each surface to be joined with sandpaper, steel wool or a wire brush? •Make sure all grease or paint is removed where solder is to be applied?
Sweat solder lap-joints of brass, tinned steel and stainless steel by soldering iron and torch methods.	•Tin each surface prior to making each sweat joint? •Select proper type of solder for each type of metal? •Use an adequate soldering iron and proper torch setting? •Clamp pieces to be joined rigidly before sweating them together? •Use proper precautions against spattering of solder or flux? •Apply solder and flux properly? •Wait until solder is set before removing from clamps?
Clean after sweat-soldering.	•Properly clean each joined sample as appropriate for the flux used?

REPAIR STEEL PARTS BY WELDING.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Written welding information, AC 43.13–1 or equivalent publication, welding equipment, a portable welding set, samples of damaged or defective aircraft parts, some of which are repairable by welding.

- **Performance:**
  The student will identify and select parts which he considers repairable by welding. He will set up a portable gas welding set, clean and prepare steel parts for welding, and use the portable welding set to repair the steel parts by welding. He will preheat the parts, select correct size tip and adjust an oxy-acetylene torch for correct type flame, select and use filler rod; perform welding of the steel parts and normalize them.

- **Standard:**
  All steps will be performed in accordance with procedures provided and completed welds will comply with the requirements of AC 43.13–1 or equivalent publication.

Key Points	*Feedback*
Definitions and comparison of soldering, brazing and welding.	•Define soldering and compare with welding to emphasize difference between adhesion vs. fusion. •Compare the temperatures required for soft and hard soldering with those required for welding. •How does brazing compare with welding? •Compare the fatigue characteristics of soldered, brazed and welded joints.
Welding methods.	•What is the usual gas combination used for gas torch welding?
a. Gas torch.	•What are some special applications where oxy-hydrogene welding is used? •Why are most portable welding sets limited to the oxy-acetylene type?
b. Electric arc.	•What are the limitations to the use of electric arc welding for aircraft line repair work?
c. Inert gas arc welding.	•Describe some repairs to an airplane where heli-arc welding is used. •Why is heli-arc welding usually restricted to specialists?
d. Specialized methods of welding.	•Name some aircraft applications of spot and flash welding. •Briefly discuss electron beam welding.
Welding of aluminum, magnesium and titanium.	•Why is welding of aluminum, magnesium and titanium generally limited to specialists?
Spot welding of stainless steel.	•Where can instructions for spot welding of stainless steel be found? •How can leaky or porous weld areas in stainless steel seam welds be repaired?
Safety precautions before and during welding.	•List the safety precautions that must be observed when setting up gas welding equipment. •When should goggles, face mask, and helmet be worn during gas or arc welding? •Explain what dress precautions should be taken for protecting the body and clothing from fire burns. •Why must oil never be used on welding gauges, torch valves, torch tips, etc. •What precautions must be taken to protect other mechanics working the area while welding? •What should be done to protect the structure and coverings of the aircraft while welding?
Operation of gas welding equipment.	•How far should the shutoff valves on the cylinder be opened? •How is the proper size tip selected? •Explain how the flame on a torch is adjusted? •What torch flame is generally used for welding? •Name some other torch flame settings and describe when each may be used.

	•Describe the approximate temperature range of each type of flame.
Welding precautions.	•List the precautions to be observed when applying heat for welding operations. •What happens to steel structures previously welded if the old weld is not removed? •Why must welding over previously brazed joints be avoided?
Weldable steels.	•Name three steel alloys that are weldable by conventional gas and arc welding. •Name three steel alloys that are not weldable.
Determining what can be repaired by welding.	•What factors must be considered in determining whether a damaged or broken part can be welded? •Where can information be found to assist in determining what steel alloys are considered weldable? •How does the location of the damaged part in the airplane affect the decision?
Preparation of parts for welding.	•Describe the methods of cleaning areas to be welded. •What procedure will assure adequate weld penetration? •What preparation should be made to hold parts rigidly in place during welding? •What determines the need to preheat a joint to be welded?
Gas flame welding procedures.	•What are specific uses and advantages or disadvantages of each type of flame? •Where are the conditions of a complete weld listed? •What practices should be guarded against in welding?
Brazing.	•Where are specifications written regarding acceptable welding and brazing operations in the aircraft structure? •Why should an aircraft mechanic be familiar with and know where to find specifications which control brazing repair operations? •Name several brazing alloys and describe where each is used. •Describe how brazing is done, and tell why a flux is used. •Why must all traces of flux be removed after brazing a joint?
Types of arc welding equipment.	•Explain how arc welding equipment is set up. •What are the advantages and limitations of AC and DC arc welders? •What are the FAA requirements regarding the making of repairs with arc welding equipment? •Describe the limitations for use of arc welding for repairs to steel aircraft structures.
Preparation for arc welding.	•Explain the preparation of structure for arc welding, fluxes used, and cleaning necessary. •Explain the correct preparation of a joint for arc welding.
Inspection of completed welds.	•How should a weld be inspected? •What is the advantage of using a magnifying glass?
Annealing and normalizing.	•What is the difference between annealing and normalizing?

Activities	*Check Items*
	Did the student:
Set up portable gas welding equipment.	•Prepare the welding equipment for proper ease of handling and safe operation?
Prepare damaged steel parts for repair by welding.	•Clean the areas to be welded and grind for proper weld penetration?
Select proper tip and preheat areas to be welded.	•Determine type of tip as specified for the material to be welded? •Properly clean the tip before using? •Use goggles or face mask and helmet?
Set for proper flame and weld the prepared areas.	•Set for correct flame type?
Select and use proper fill rod.	

Normalize the repaired parts after welding is completed.	•Inspect all welded areas to assure penetration was thorough and fusion at edges was adequate? •Follow proper procedures for normalizing each welded part?

18. FABRICATE TUBULAR STRUCTURES. (EIT = 6 hrs., T = 6 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

TUBULAR STEEL FABRICATION AND REPAIR BY WELDING.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written welding information, AC 43.13–1 or equivalent publication, samples of aircraft tubular structure which include tubular steel welding splices, joints, and clusters, with repaired dents or flaws, some of which do not meet return-to-flight standards.

- Performance:
  The student will identify ten welded splices, joints, and sleeve repairs in tubing and tubular welded clusters. He will inspect ten samples of aircraft welded tubular structures and list whether each selected weld meets return-to-flight standards as specified in FAA publications.

- Standard:
  Correctly identify at least seven welded samples, and correctly judge return-to-flight acceptability for at least seven welds.

Key Points	*Feedback*
Aircraft tubular steel structure welding.	•Interpret the dimensions and explain how to fabricate the types of tubing welds displayed in AC 43.13–1 or equivalent publication. •Describe the sequence of welding a steel tubing fuselage.
Characteristics of an acceptable weld.	•Identify the characteristics which would lead to acceptance or rejection of a welded tubing joint repair. •Describe the types of tubing splices which are acceptable. •Where is the use of outer tube splicing not permitted?
Repairing dented tubular steel structures.	•Describe methods of repairing dents in clusters and bays. •Name the precautions or practices to be guarded against when making a welded repair.
Alloy steel parts not to be welded.	•Explain what is meant by an alloy steel. •Why are some steel parts of the airplane not to be welded by the mechanic? •What is the effect of carbon as an alloy?
Tubular structure welding procedures.	•What must be known about steel tubular structure before beginning a welded repair? Why?
a. Evaluation of material.	•Name the steels that are readily weldable.
b. Preparation.	•What should be done to prepare a steel tube cluster repair for welding? •How are the tube ends prepared? •What are some of the cleaning operations to be performed before beginning a welded repair?
c. Alignment of tubular members.	•Explain what is meant by "center line" alignment when tubular clusters are made. •Describe a fixture which could be used for keeping tubular structures aligned when making a welded repair. •Describe the methods used to control distortion of steel tube structures during welding repairs.
d. Sequence of welding.	•What is the proper sequence when welding fuselage tubes? •How is tubular structure checked for alignment after a welded repair is made?
e. Normalizing.	•When is heat treatment required following a welded repair? •Why is "normalizing" required after welding repairs are made to tubular structures?

Protection of interior of tubing that is closed by welding.	• How is the interior of welded steel tubular structure protected against rusting?
Tools required for tubular structure welding.	• Describe the tools needed for cutting, grinding and drilling steel tubing. • What tools are needed for measuring and laying out patches and sleeves for repairing tubular steel structures?

19. SOLDER STAINLESS STEEL. (EIT = 1 hr., T = 1 hr., L/S = 0 hr.) 1 segment

(UNIT LEVEL 1)

SILVER SOLDERING OF STAINLESS STEEL.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Written reference information and questions having to do with silver soldering of stainless steel, preparation of the metal before soldering and methods of cleaning it after soldering.

- **Performance:**
  The student will answer ten questions concerning the uses of silver solder for stainless steel bonding, how the metal should be prepared, soldering tools to use, required soldering temperatures, and methods of cleaning after soldering.

- **Standard:**
  Correctly answer at least seven of the ten questions in accordance with the information provided.

Key Points	*Feedback*
Stainless steel types and structures which can be soldered.	• Name the types of stainless steel which can be soldered by lead-tin solder and/or silver solder. • What structures in an aircraft when made of stainless steel are permitted to be soldered?
Types of soldering for use with stainless steel.	• Compare the strength of a 50/50 or 60/40 lead-tin alloy joint with a silver solder joint. • Explain how the flux used for stainless steel soldering effects the metal.
Silver soldering techniques.	• What temperature range is required for silver-soldering? • Why must a torch be used to obtain the needed temperature to silver solder metals, especially stainless steels?
Methods of cleaning material after soldering.	• What methods can be used for cleaning stainless steel after soldering and how important is it that the flux be completely removed? • Is it permissible to file or grind down the soldered area? • Why should the flux be removed from the solder as well as the surrounding surface?

20. WELDING STAINLESS STEEL AND ALUMINUM. (EIT = 3.5 hrs., T = 0.5 hrs., L/S = 3 hrs.) 1 segment

(UNIT LEVEL 2)

INSPECT AND WELD ALUMINUM AND STAINLESS STEEL.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information and questions concerning welding of aluminum and stainless steel, welding equipment, samples of acceptable and unacceptable inert-gas welds, and samples of aluminum alloy sheet and stainless steel sheet.

- **Performance:**
  The student will answer six questions having to do with welding of aluminum and stainless steel, use of aluminum filler rod, the purpose and effect of using inert-gas to shield the arc in welding, and limitations in using inert-gas welding methods for aircraft line repairs. He will inspect five samples of inert-gas arc welds of aluminum and/or stainless steel and record the acceptability of each. He will make welded bead seams on samples of aluminum alloy and stainless steel sheet.

- **Standard:**
  Correctly answer at least four questions, correctly record acceptability of at least three sample welds, complete at least one welded bead each on sample aluminum alloy and stainless steel and identify flaws in the welds when completed.

Key Points	*Feedback*
Aluminum welding processes.	•Name three processes by which aluminum can be welded. •Why are aluminum castings and forgings not generally repaired by welding? •In general, what determines whether an aluminum alloy is weldable? •Is aluminum generally repaired by welding when accomplishing field repairs? Why?
Aluminum welding techniques.	•In welding of aluminum, when is it necessary to preheat? •How is filler rod used in welding aluminum? •What is the purpose of flux in welding aluminum? •How is flux removed? •Why is it not necessary to use flux when heli-arc welding aluminum? •Name two advantages of heli-arc welding.
Aircraft uses of stainless steel.	•What parts of the airplane may be made of stainless steel?
Welding of stainless steels.	•Name three methods used in welding stainless steels. •What is the most common method used today? •What are the limitations in the use of each method in aircraft line maintenance?
Carburization.	•Why is it important to keep carburization to a minimum?
Use of flux.	•Where is flux applied to a joint to be welded? •What purpose does the flux serve in the welding process? •How is flux removed?

Activities	*Check Items* Did the student:
Inspect aluminum welds. Select acceptable welds and identify flaws in unacceptable samples.	•Locate appropriate reference materials? •Inspect sample welds with a magnifying glass and determine if welds are airworthy?
Weld aluminum, make a welded bead on aluminum alloy sheet.	•Select proper tip to obtain a large enough flame size to compensate for high heat transfer in aluminum? •Use flux properly?
Use flux and filler rod in welding a seam bead in aluminum alloy sheet material.	•Select proper filler rod? •Use filler rod properly to produce a uniform bead? •Avoid excessive heat to prevent oxidation of aluminum?
Inspect stainless steel welds. Identify characteristics which determine acceptability of a stainless steel weld.	•Locate appropriate reference materials? •Inspect sample welds with a magnifying glass and determine if welds are airworthy?
Weld stainless steel by making a seam bead on a sample sheet. Identify flaws in completed weld.	•Select proper tip and set for adequate flame? •Use correct flux? •Recognize flaws in the weld by reference to information provided?
Identify cause of warping of welded sheet.	•Recognize causes of excessive warping of stainless steel sheet when being welded?

21. WELD MAGNESIUM AND TITANIUM. (EIT = 2 hrs., T = 2 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

WELDING OF MAGNESIUM AND TITANIUM.
(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written information and questions with multiple choice answers regarding welding of magnesium and titanium.

- Performance:
  The student will select answers to ten questions covering the method of cleaning magnesium for welding, the function of flux, the types of gasses to use, the use of butt joints when welding magnesium, and the methods of welding titanium.

- Standard:
  Select correct answers for at least seven questions.

Key Points	*Feedback*
Methods of welding magnesium.	•Compare the welding of magnesium with the welding of aluminum.

a. Gas welding.	•What type of flame is used to weld magnesium by oxy-acetylene? •Why is it important to remove all flux from a magnesium weld?
b. Inert gas arc.	•What are the advantages of welding magnesium by the inert gas arc method?
Limitations.	•What are the limitations to accomplishing inert gas welding of magnesium in line work? •Why is it not recommended to weld structural parts of magnesium? •Can magnesium be welded to aluminum or other metals?
Methods of welding titanium.	•Compare the welding of titanium with the welding of stainless steels. •Why is titanium welding usually limited to shops with heli-arc specialists?

ASSEMBLY AND RIGGING

22. RIG FIXED WING AIRCRAFT. (EIT = 9 hrs., T = 4 hrs., L/S = 5 hrs.) 2 segments

(UNIT LEVEL 2)

USE CORRECT AIRCRAFT NOMENCLATURE.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Information sheets illustrating propulsion devices (propeller, jet and rocket, fuselage, wing and tail configuration, landing gear arrangements, and appropriate reference manuals.

- **Performance:**
  The student will label the sketches in the information sheets to classify the types of powerplants and the design features of the airplane.

- **Standard:**
  The student will correctly identify and label 80 percent of the features appearing in the drawings or sketches.

Key Points	*Feedback*
Classification by powerplants.	•What kinds of powerplants may be used to drive a propeller? •As a propeller has a limiting speed in terms of RPM, how may the high RPM of a turbine engine be coupled to a propeller? •What is the difference between a turbojet and a fanjet engine? •What is a rocket engine? •What is a ramjet engine and what application is currently forseen for this type of powerplant? •Describe an internal combustion engine. •Explain the differences between a turbine engine and a reciprocating engine.
Classification by wing configuration.	•Distinguish between a high-wing, low-wing, biplane and midwing airplane. •What is the difference between a full cantilever and a semi-cantilever wing design? •Describe and illustrate the shape of each of the following wing planforms: a. Straight wing. b. Tapered wing. c. Swept wing. d. Delta wing. e. Elliptical wing.
Classification by tail surface configuration.	•What is meant if an empennage is described as multifinned or "V" tailed? •What design features identify a cantilevered tail group? •Describe the type of horizontal tail surface that is called a "slab" or flying tail. •What is a stabilator?
Classification by landing gear configuration.	•What features of the design permit the identification of each of the following types of landing gears: a. Tailwheel type? b. Tricycle type? c. Tandem bogie? •What design features permit identification of retractable and fixed landing gear types?
Nomenclature of aircraft components: a. Fuselage.	•Describe the differences between a moncoque and a semi-monocoque type of fuselage. •If a fuselage is covered with fabric, what type of structure is provided to carry the loads imposed on the airplane?
b. Wings.	•What features are described when a wing structure is identified as "wire braced"? •What is the difference between a lift strut and a jury strut? •What is a cabane strut? •What is meant by the term "stressed-skin" construction? •How would a mechanic distinguish between a monospar and a multi-spar wing? •Describe what is meant by a wing stringer.

	•Identify and distinguish between the leading edge, trailing edge, and tip of a wing. •What features identify a laminar flow wing? •What is a wing vortex generator?
c. Empennage and control surfaces.	•Why is the term "fin" often used to describe a vertical stabilizer? •What name is used to describe the movable portion of the vertical stabilizer? •What features identify a "stabilator"? •What name is given to the movable portion of the horizontal stabilizer? •Describe a trim tab. What is the difference between a trim tab and a servo tab? •Describe the difference between an aileron and a flap. •What is the difference between a slot and a slat? •What is a spoiler? What is a "dive brake"? •What is the difference between the "mass" balance and the aerodynamic balance of a control surface? •As they are part of the operating linkage of control surfaces, describe and identify each of the following: a. Surface hinges. b. Bellcranks. c. Fairleads. d. Pulleys. e. Power-boosted or power-operated controls. f. Actuators and artificial feel devices. •What is the difference between a cable operated control system and a push-pull system?
d. Landing gears.	•Describe a tandem (bogie) or multi-contact type of landing gear. •What is a cross-wind type of landing gear? •What is a shock strut? •What are some of the methods that may be used to retract a landing gear? •What is a landing gear door?

INTERPRET THEORY OF FLIGHT.

(SEGMENT B, LEVEL 2)

Student Performance Goal

● Given:
Information sheets containing unlabeled line drawings or sketches illustrating the aerodynamics of flight and/or a model of a fixed wing airplane.

● Performance:
The student will explain the aerodynamics of flight, interpret the theories and describe the design features related to lift, thrust, stability and control of fixed wing aircraft. Using a three-view plan, drawing, sketch or model airplane, the student will:

a. Identify, and label the three axes of the aircraft.
b. Illustrate the displacement or motion of an airplane about each of the three axes.
c. Describe the aerodynamics forces action upon an airplane in flight.
d. Describe the design features which contribute to the stability of the airplane.
e. Illustrate the relationship between center of pressure and center of gravity at three different angles of attack. With the aileron and flap in various displaced positions, the student will illustrate the movement of the center of pressure on the airfoil.

● Standard:
The student will use correct nomenclature when labeling diagrams or describing aerodynamic effects. Illustrations will be correctly labeled.

Key Points	*Feedback*
The atmosphere.	•Explain how temperature and humidity affect the density of the air. •What is meant by the term, "standard" day? •What is the relationship between an indicated air-speed, calibrated air-speed and true airspeed? •Explain why an airplane will not take off and climb as well on a hot humid day as it will on a cold, dry day.

Lift and drag.	•Explain how each of the following factors influence the lift of a wing or airfoil: a. Motion of the airfoil. b. Relative airflow. c. Angle of attack. d. Airfoil characteristics, i.e., lift/drag characteristics. •What is a resultant force, as applied to the forces acting on an airfoil? •What is meant by the term "stall" as applied to an airfoil? •What is turbulent airflow? •What are some of the factors which influence the drag characteristics of an airfoil? •How is the lift and drag of an airfoil affected by a change in angle of attack?
Airfoil and streamlined shapes.	•What is a center of pressure? •In which direction does a center of pressure move with an increase in the angle of attack? •How does the drag of a streamlined body compare with the drag produced by a circular shaped body?
Drag components.	•What is skin friction? •Distinguish between profile drag and induced drag. •What is interference drag? •What is a laminar flow? What is meant by the term "boundary layer"?
Characteristics of airfoils.	•What is a lift/drag ratio? •Compare the camber of a high lift wing to the camber of a high speed wing. •How is the shape of an airfoil related to shock waves and critical Mach number? •What purpose does a wing fence serve on a swept wing? •What effect does a wing tip vortex have on the lift produced by a wing?
Lift and drag devices.	•Describe the differences between plain, split and Fowler type flaps. •Compare the effect of slots and slats. •Describe the action and effect of a spoiler on a wing.
Thrust.	•Explain how a propeller or a jet engine produces thrust. •Explain how the limiting tip speed of a propeller is related to efficiency. •Under what condition is a fan jet engine more efficient than a regular turbojet engine? •In what environment does a rocket engine have superiority over propeller and turbine engines?
Stability and control.	•Explain why lift, thrust, gravity, and drag are equal when an airplane is in straight, level, constant speed flight. •What is meant when an airplane is described as being stable? •What is the difference between static and dynamic stability?
a. Longitudinal stability.	•What is the relation of the position of center of lift and center of gravity? •What is a center of gravity? What is a center of gravity range? •What is the function of a variable tail plane on an airplane?
b. Directional stability	•What is the function of a vertical tail plane? •Why do some designs include a ventral fin? What is the effect of a dorsal fin? •What is "keel effect" of a fuselage?
c. Lateral stability.	•How does dihedral/cathedral contribute to lateral stability of the airplane? •What is the effect of sweepback on lateral stability?
d. Control of the airplane.	•Name and identify the three axes of an aircraft and the control surfaces which provide for rolling, pitching and yawing. •What are some of the factors which may cause flutter of a control surface? •Describe the action of a servo or booster tab.

Maneuvers. a. Straight and level flight.	•What is the difference between angle of incidence and angle of attack? •What design features may be incorporated to compensate for the torque effect of the engine/propeller? •What design features may be incorporated to provide directional stability to the airplane? •What features contribute to lateral stability? •For what flight condition is an airplane rigged?
b. Performance limitations.	•For what reasons may an airplane be placarded to prohibit specified maneuvers? •What is the effect of gusts and turbulence upon an airplane in flight? •How does wing loading and power loading relate to performance of an airplane?

Activities	*Check Items*
	Did the student:
Label drawings provided in the information sheets to illustrate: a. Three axes of an airplane. b. Motion around the axes. c. Aerodynamic forces. d. Center of pressure and center of lift. Use model or sketches to interpret the theories and explain the aerodynamics of flight.	•Use correct nomenclature and correctly label each drawing? •Correctly describe airflows and interpret the principles of density, center of lift, etc.?

23. RIG ROTARY WING AIRCRAFT. (EIT = 8 hrs., T = 8 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

USE NOMENCLATURE APPLICABLE TO ROTARY WING AIRCRAFT.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
Information sheets containing unlabeled drawings of rotary wing aircraft and appropriate rotary wing reference manuals.

- Performance:
The student will label the drawings, identifying the three axes of a rotorcraft and the movement about each of the axes induced by operation of the flight controls. He will locate information in the manual which will enable him to recognize and explain:

  a. The cause and effect of blade stall when helicopters are operating at high speed.
  b. The cause of vertical vibrations.
  c. The methods of tracking main rotor blades.
  d. The preparation required prior to rigging a rotorcraft.

- Standard:
The drawings will be correctly labeled. Correct nomenclature will be used throughout the explanations.

Key Points	*Feedback*
Rotary wing characteristics.	•What is the primary difference between a helicopter and an autogyro? •Why is the weight and balance critical on rotary wing type aircraft? •What characteristics are involved in determining whether a helicopter will have a single rotor, dual rotor or multi-bladed rotors?
Axes of a rotorcraft.	•Identify and describe the position of the longitudinal, lateral and vertical axes.
Primary flight controls.	•What effect does the rudder have on the control of a helicopter? •What is the effect of collective pitch on the movement of a helicopter? •What effect does the torque-rotor have on a helicopter? •What is the meaning of the terms "retreating/advancing" blade as applied to the helicopter? •Why do some rotary wing aircraft employ cyclic pitch in the main rotor assembly? •What are some of the factors which currently limit the speed of helicopters?
Maintenance concepts.	•Using the maintenance manual as a reference, describe the safety precautions to be observed when tracking a rotor blade.

- What are some of the causes of vertical vibrations in a helicopter?
- What ratio vibration will result from an "out-of-track" rotor blade?
- What is the first step in preparing a helicopter for rigging?

24. CHECK ALIGNMENT OF STRUCTURES. (EIT = 10 hrs., T = 2 hrs., L/S = 8 hrs.) 1 segment (UNIT LEVEL 2)

VERIFY ALIGNMENT OF STRUCTURE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Written procedure sheets, appropriate reference manuals and an airplane or aircraft mock-up with an airplane fuselage, landing gear, wing structure and empennage.

- Performance:
  The student will level the fuselage and verify alignment of the structure. On an internally braced wing section, the student will use tools and make adjustments to ensure the alignment of wing spars, squareness of bays and tension of the bracing. Using the data available in the manufacturer's manuals, he will interpret the information and make the measurements necessary to verify the alignment of landing gear, wings and fixed tail surfaces.

- Standard:
  All measurements will be made in accordance with the procedures provided. Adjustments will be made as needed to align the structure within the tolerances specified in the manuals.

Key Points	*Feedback*
Fuselage station numbering systems.	•What is the purpose and use of station, buttock and waterlines? •Where is the "zero" station of a fuselage usually located? •Why is the alignment of a fuselage critical? •What could result if a fuselage is twisted? •Where would a mechanic find information that would specify the leveling methods for a particular type and model of airplane? •How could a mechanic verify the accuracy of a spirit level or a bubble protractor? •In what manner could plumb bobs be used to verify alignment of a fuselage?
Wing station numbering systems.	•What is the correct starting point when tramming a wing? •How are the tramming points of a wing established? •Name the tools that would be used and describe the procedure that would be followed to tram a wing. •What problem exists if the bays of a wing are square but the spars are not straight? •How can a mechanic determine the correct tension for the drag and anti-drag wires?
Using manufacturer's manuals.	•What tools are necessary and what procedure would be followed to verify the "rig" and alignment of the fixed tail surfaces of an airplane? •If the manual indicates that the vertical fin is "off-set," explain the reason for and the direction in which the fin will be off-set. •Describe a procedure that could be used to measure: a. Incidence of a wing. b. Dihedral. •Explain why wings are "washed-in and washed-out" and what flight characteristics will result if a wing has excessive wash-in. •How does "wash-in and wash-out" affect the directional stability of an airplane? •What design feature permits adjustment of the angle of incidence on wings which have only a single strut at the main spar? •Explain why some airplanes have "off-set" and/or canted thrust lines for the engines. •Where would such information be published?

Activities	*Check Items* Did the student:
Level and check alignment of a fuselage.	•Locate and correctly interpret reference information? •Use tools prescribed in the procedure sheet? •Follow correct procedures?
Adjust, align, and tension an internally braced wing.	
Check alignment of an assembled airplane, verifying: a. Gear alignment. b. Wing alignment. c. Empennage alignment.	

25. ASSEMBLE AIRCRAFT. (EIT = 7 hrs., T = 1 hr., L/S = 6 hrs.) 1 segment

(UNIT LEVEL 3)

ASSEMBLE COMPONENTS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  An assembly project, mock-up panel or an identifiable assembly of typical components on an airplane (landing gear, control surface, etc.) and a procedure sheet, drawing or maintenance manual.

- **Performance:**
  The student will identify and select the required hardware (bolts, nuts, screws, etc.) from an assortment or supply room. He will install, torque and safety these fasteners on the mock-up panel or in the assembly.

- **Standard:**
  The procedure, torque valves and safeties will be in accordance with the procedure sheets, drawings or the manufacturer's manuals.

Key Points	*Feedback*
Bolted installations.	•In what directions are the bolts usually installed in an airplane? Give examples of some conditions which might cause bolt direction to vary from the general installation criteria. •What is meant by the term "interference" fit? •How is the grip length of a bolt measured? •Describe some conditions that preclude the use of drilled shank aircraft bolts.
Aircraft nuts.	•What is the difference between a plain nut and a check nut? •What is the difference between a shear nut and a castle nut and may they be used interchangeably? •Describe three different types of self-locking nuts. •What are the limitations imposed on the use of self-locking nuts on drilled bolts? •How many threads of the bolt must project through the fiber collar of a self-locking nut? •Describe some of the limitations to the use of self-locking nuts.
Safetying devices.	•Name two of the materials from which cotterpins are manufactured. •Name two of the materials from which safety wire is manufactured. •How may a mechanic distinguish between a lock washer and a shake-proof washer? •What will most likely result if a safety wire is twisted too tightly? •Why are cotterpins not considered an acceptable safety for nuts installed on studs?
Screws.	•What are some of the differences between a machine screw and an NAS screw? •How may a mechanic identify and distinguish between a stress screw and a clevis bolt?

Activities	*Check Items* Did the student:
Install components on mock-up or assembly using bolts, screws, nuts and safeties.	•Use the hardware specified in the procedure sheets or manual? •Follow the procedure specified?

- Torque to correct values?
- Safety the completed assembly?

26. BALANCE AND RIG MOVABLE SURFACES.

(EIT = 24 hrs., T = 4 hrs., L/S = 20 hrs.)
6 segments

(UNIT LEVEL 3)

IDENTIFY AIRCRAFT CONTROL CABLE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Assorted samples of aircraft control cables, identification tags, and reference catalogs or appropriate publications.

- Performance:
  The student will measure the diameter of each cable, determine the material from which the cable was manufactured, tag the cable, identifying the diameter type, material and approximate tensile strength.

- Standard:
  Identification of the cable diameter, type, and material will be without error. Tensile strength will be identified in accordance with reference information.

Key Points	*Feedback*
Types of control cable. a. Non-flexible. b. Flexible. c. Extra-flexible. d. Fiber cores.	• What is meant by a "single wire" in an aircraft control cable? • How would a mechanic identify the core strand in a piece of aircraft control cable? • What name is given to a process of manufacturing in which the wires and strands are shaped or formed before the cable is woven into final shape?
Size of cable.	• Since a cable is not a perfectly circular shape, how is the diameter of a cable measured? • Is the diameter of a control cable measured in fractions or decimal graduations? • What is the smallest diameter cable which may be approved in the primary flight control systems of an airplane?
Materials.	• What material is used in the production of control cables for a float plane or amphibian? • What simple test may be employed to identify a stainless steel control cable? • What is the name of one of the common protective finishes that is applied to control cables?

Activities	*Check Items* Did the student:
Tag cables, identifying diameter, type of cable, material and approximate tensile strength.	• Use the correct tools to measure the diameter of the cable? • Correctly judge materials and determine the type of cable? • Use reference information to determine tensile strengths?

INSTALL SWAGED CABLE TERMINALS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  A 24 inch length of 7 X 19 aircraft control cable, a project jig and the appropriate terminals and tools, AC 43.13-1 or equivalent publication.

- Performance:
  The student will install a nicopress sleeve and thimble at one end of the cable and a swaged fitting at the other end. He will cut the cable in two and splice with nicopress sleeves to the predetermined dimensions of the project jig.

- Standard:
  All procedures will comply with the quality standards of AC 43.13-1 or equivalent publication.

Key Points	*Feedback*
Nicopress terminals.	• What are the two types of cable terminal ends? • What percentage of the cable strength may be maintained in a swaged type terminal? • What percentage of the cable strength may be maintained in a hand tucked splice?

	•What materials are used in the manufacture of nicopress sleeves? •Describe the correct sequence for swaging a nicopress sleeve.
Swaged terminals.	•Describe the shapes of four different types of swaged terminals. •Why is it a good practice to slightly bend the cable as it is positioned into the fitting before swaging? •How is masking tape used to detect slippage during swaging of a terminal? •What is the purpose of the paint that is applied between the cable and the swaged terminal? •By what method is the acceptability of the swaging operation judged?
Cutting control cables.	•Describe two acceptable methods for cutting aircraft control cables. •Why should a welding torch not be used to cut control cables? •Why is a hacksaw not an acceptable tool for cutting cable? •What procedure may be used to prevent fraying of a control cable as it is cut?

Activities	*Check Items* Did the student:
Install a nicopress terminal, sleeve and thimble.	•Follow correct procedure when swaging the nicopress sleeve? •Check the swaged sleeve for proper after-swage dimensions?
Install swaged terminal (eye, fork or threaded end terminal).	•Insert cable to correct depth in terminal and mark to detect slippage? •Swage terminal and check dimension following swaging? •Inspect swaged terminal for deformation?
Cut cable.	•Wrap cable to preclude fraying and cut in an acceptable manner?
Splice cable to length using two nicopress sleeves.	•Achieve correct length of spliced cable? •Swage nicopress sleeves in correct sequence?

VERIFY CORRECT CONTROL RESPONSE.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A completely assembled airplane with operating primary and secondary flight controls and a diagram, drawing or sketch of the control surfaces of the airplane.

- Performance:
  The student will, while seated in the pilot or copilot's position, physically move each primary and secondary flight control. On the drawing or sketch, he will write the direction that the control surface moves, the reaction of the airplane to this applied control. He will explain the purpose of differential control and the function of control surface locks.

- Standard:
  The diagrams will be correctly labeled and explanations will be without error.

Key Points	*Feedback*
Control movement and resultant control surface displacement.	•In which direction is the control wheel rotated to move the right aileron down? •In which direction is the control yoke moving as the elevator travels upward? •If the right rudder pedal is moving forward, in which direction is the rudder moving?
Control surface displacement and resultant action of the airplane.	•When the elevator is moved downward, how does the airplane react? •Around which axis does the airplane rotate when the control wheel is rotated? •How does the airplane react to forward movement on the control yoke?
Effect of tabs on primary control surfaces.	•In which direction will an elevator tab move as the trim tab control is moved toward the "nose-up" trim position? •In which direction will a rudder tab move as the rudder trim control is moved to a nose-right position?

	• In which direction will an elevator servo tab move when the control column is moved forward?
Controllable flaps, slots and high-lift, high-drag devices.	• What hazard is associated with unequal or assymetrical flap positions? • Why do ailerons often have greater up-travel than down-travel? • Why do the elevators often move farther in their up travel? • What mechanical device or linkage permits differential travel within a control system?
Control locks.	• What is the function of a control surface lock? • What hazard could exist if control locks are engaged during flight?

Activities	*Check Items* Did the student:
Move flight controls and label diagram or drawing to illustrate control and airplane response.	• Correctly diagram the control responses? • Interpret reaction of the airplane to the control surface displacement? • Use correct nomenclature as part of the explanation?

INSTALL AND TENSION A CONTROL CABLE, INSPECT A CABLE CONTROL SYSTEM.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  A specified make and model of airplane, the associated service manual, a replacement control cable for one of the flight controls, appropriate tools, and an inspection report form.

- Performance:
  The student will install an elevator, rudder, or aileron cable, use a tensiometer to establish correct cable tension, safety all turnbuckles and attaching devices in accordance with the service manual. He will inspect the control systems of the airplane for cable wear, tension, pulley wear and rotation, swaged terminal slippage, turnbuckle safety, corrosion and control surface travel, and record discrepancies on a report form.

- Standard:
  Work accomplished will be of return-to-flight quality. Descrepancies found during inspection of the control system will be recorded in accordance with Chapter 4, AC 43.13-1 and the airplane service manual.

Key Points	*Feedback*
Removal and installation of a cable.	• What is the purpose of a cable quick-disconnect? Where are quick-disconnects usually located in the system? • If a cable does not incorporate a quick-disconnect, how is the cable disconnected from the system? • As a cable is being removed, what is the function of a cable "snake"? • What airworthiness standards apply to bent, kinked, rusted, corroded cables, or to cables with broken wires? • What are the limits of angular alignment of cables into pulleys and fairleads? • What effect does temperature have on the tension of control cables? • What are some of the results of over-tensioning of the cables in a control system? • Why are temperature compensators rarely found in the cable systems of single engine airplanes?
Tension of cables.	• How may a mechanic verify the accuracy of a cable tensiometer? • What features of some tensiometers makes it possible to read cable tensions when the dial of the tensiometer is not visible? • What problem may occur if a mechanic fails to hold the cable terminals while rotating the barrel of a turnbuckle? • What is the procedure for applying paralketone to a control cable? What kinds of cable do not require corrosion protection?

Standard cable hardware. (Clevises, shackles, clevis pins, bolts, nuts, pulleys, turnbuckles, etc.)	•From what materials are pulleys made? •How is the size of a pulley measured? •What kinds of pulleys require lubrication? •Describe a technique that may be used to detect broken wires in a cable. •At what position along the length of a cable is wear most likely to occur? Where will corrosion occur? •What is the purpose of a pulley guard? •What limits are usually applied to wear in the cable groove of a pulley? •Describe the conditions which lead to "brinnelling" of the bearing in a pulley. •Describe the wear pattern which would be sufficient cause for rejection of a fairlead. •What is the maximum thread exposure beyond the barrel of a turnbuckle assembly? •How may a mechanic distinguish between a "long" and a "short" turnbuckle barrel?
Control surface travel.	•Where does a mechanic find published specifications pertaining to control surface travel? •Describe some of the methods used to limit control surface travel. •Why is over-travel or under-travel of a control surface critical?

Activities	*Check Items* Did the student:
Remove and install a control cable.	•Locate information in reference manuals? •Follow prescribed procedure? •Block or lock the controls in neutral? •Use snakes to insure correct passage and path of cable? •Use correct attaching hardware? •Adjust and check tension? •Safety in accordance with manual and/or AC 43.13-1?
Inspect complete cable operated control system of a specific airplane.	•Use appropriate reference manuals? •Follow prescribed procedure? •Remove necessary inspection plates and panels? •Inspect cables (release tension and reverse bending cable in suspect areas)? •Check pulleys for wear, rotation and lubrication—pulley brackets and guards? •Inspect cable terminal ends and attaching hardware? •Re-tension cables to specifications? •Check control surface travel? •Safety as required?
Record discrepancies on report form.	•Make written record of discrepancies as found?

CHECK STATIC BALANCE OF A CONTROL SURFACE.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- Given:
  A balanced type aircraft control surface which is not in balance and the manufacturer's service instructions.

- Performance:
  The student will interpret the manufacturer's instructions, follow procedure and use equipment to check the unbalance of the control surface. He will recommend correct action to balance the surface.

- Standard:
  The corrective action recommended by the student will be in accordance with the procedure recommended in the manual.

Key Points	*Feedback*
Balanced control surfaces:	•Why are the movable control surfaces of some airplanes balanced?
a. Static balance.	•How critical is the balance of a control surface? For example, if a balanced control surface is re-painted, should the balance be checked?

b. Aerodynamic balance.	•How is aerodynamic balance of a movable surface achieved? •Distinguish between static and dynamic balance of a control surface.
Check balance of a control surface.	•Locate reference information in manufacturer's service manual? •Install surface in balancing fixture and make an inspection for accumulated dirt, debris or damage? •Follow instructions and procedure for using balance weights and balance arm jig? •Correctly judge the balance of a control surface?
Recommend corrective action to balance the surface.	•Outline procedure and interpret information regarding rebalancing of a surface?

INSPECT AND ADJUST PUSH-PULL CONTROL SYSTEMS.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- Given:
  Written procedures and inspection report forms and an airplane incorporating a push-pull control system.
- Performance:
  The student will inspect the bellcranks, push-pull tubes, rod ends, guides, adjust the travel of the movable control surfaces and safety the control system in accordance with the service manual for that particular make and model of aircraft.
- Standard:
  Inspections, adjustments and safetying of the system will meet return-to-flight standards.

Key Points	*Feedback*
Push-pull and torque tube type actuating systems.	•How does the size of an airplane limit the use of push-pull control systems? •What affect does temperature have on a push-pull control system? •What design feature in a push-pull control system makes it possible to inspect the engagement of threads in the terminal ends? •What safetying methods are used for the adjustable rod ends in a push-pull system? •Describe a self-aligning bearing. •How is differential travel achieved in a push-pull system? •How is the "neutral" position of a bellcrank established? •Where will the limit stops for a push-pull system be located?
Inspection and adjustment of push-pull systems.	•How is control surface travel adjusted in a push-pull system? •What reference publication would specify the lubrication requirements for self-aligning bearings? •If binding is detected at the extreme travel limit of a push-pull system, where is the fault most probably located?

Activities	*Check Items*
	Did the student:
Inspect and adjust a push-pull control system.	•Correctly interpret information from the manuals? •Follow correct inspection and adjustment procedures? •Detect wear, interference and binding in system? •Check bearing condition and requirement for lubrication? •Check thread engagement at terminals and safetying throughout the system?

27. JACK AIRCRAFT. (EIT = 3 hrs., T = 1 hr., L/S = 2 hrs.) 1 segment

(UNIT LEVEL 3)

JACK AIRCRAFT.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  A specified make and model airplane; associated service manual, jacks, jack pads and ballast.

- **Performance:**
  The student will use the appropriate equipment, ballast, and follow procedures to raise and subsequently lower the aircraft.

- **Standard:**
  Jacking of the airplane will be in accordance with the procedure detailed in the service manual.

Key Points	*Feedback*
Jacking equipment and procedures.	**•What governs the maximum allowable jacking weight of an airplane?** **•What publication will contain information detailing the type of jacks and pads to be used?** **•Under what conditions may ballast be required while jacking an airplane?** **•In general, why should all jacks be raised and lowered simultaneously?** **•If possible, why should an airplane be jacked while it is inside the hangar?** **•Why should the jacks be removed from a position under the airplane immediately after lowering the airplane onto the landing gear?** **•What are scissor chocks or strut restraint cables?**

Activities	*Check Items* **Did the student:**
Prepare area and equipment for jacking.	**•Correctly interpret information and procedure?** **•Have area and all equipment ready for jacking?** **•Correctly position aircraft for jacking?** **•Install jack pads?** **•Install ballast as required?** **•Correctly position jacks?** **•Protect aircraft from wind currents?**
Raise and lower the airplane.	**•Follow correct jacking procedure?** **•Jack evenly?** **•Position locks as jacks are raised and lowered?** **•Check overhead clearance?** **•Clear area before lowering?** **•Remove jacks immediately after lowering the airplane?**

AIRFRAME INSPECTION

28. PERFORM AIRFRAME CONFORMITY AND AIRWORTHINESS INSPECTIONS. (EIT = 20 hrs., T = 2 hrs., L/S = 18 hrs.) 1 segment

(UNIT LEVEL 3)

PERFORM 100 HOUR OR ANNUAL INSPECTION.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's and FAA manuals, written procedures and forms, and a completely assembled airplane.

- Performance:
  The student will accomplish a 100 hour or annual inspection of the airplane and record the conditions disclosed as a result of the inspection.

- Standard:
  The procedures, nomenclature and technical terms used to describe the conditions detected by the inspection will reflect return-to-flight standards.

Key Points	*Feedback*
100 hour or annual inspection.	•What established the frequency and type of inspections that are necessary to an airplane and powerplant? •Under what operating conditions does a 100 hour inspection become mandatory? •Under what conditions may an airplane be operated if a required 100 hour inspection is overdue? •Who is authorized to conduct a routine 100 hour inspection? •Who is authorized to accomplish an annual inspection? •What is the maximum time authorized between annual inspections? •How is the local FAA district office notified that an annual inspection has been accomplished? •What entry is made in the records and what form is displayed in an airplane upon completion of an annual inspection? •What time limit applies between the completion of the annual inspection and notification to the FAA field office? •If an unairworthy condition is disclosed as a result of an inspection, how may the aircraft be returned to service?
Inspection entries and records.	•In which of the logbooks is the 100 hour or annual inspection signed off? •What technical phraseology is used in the logbook entry describing an annual inspection? •If a progressive inspection is being recorded in the aircraft maintenance file, what phraseology is used to describe the inspection? •If a manufacturer's recommended inspection is conducted in lieu of the FAA recommended inspection, what phraseology is correct? •What is the importance of dating the entry describing an inspection? •Why must a mechanic sign an inspection entry and indicate his mechanic certificate number?

Activities	*Check Items* Did the student:
Inspect the airplane. Accomplish a 100 hour or annual inspection of the airplane.	•Ensure that all reference manuals, forms, procedure sheets, etc., were readily available? •Prepare the airplane and work areas for the inspection? •Review all manufacturer's bulletins, alert notices and airworthiness directives? •Conduct the inspection in accordance with a written procedure sheet?

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	•Secure all inspection openings, access doors, fairings, etc., upon completion of the inspection?
Make maintenance record entries.	•Use correct phraseology? •Make accurate, concise, legible entries? Date and sign the entry? Enter his mechanic certificate number?

OUTLINE AIRFRAME CURRICULUM – PART II, AIRCRAFT SYSTEMS AND COMPONENTS

Instructional Units, Segments and Estimated Instructional Time

AIRCRAFT ELECTRICAL SYSTEMS

1.	**INSTALL, CHECK, AND SERVICE AIRFRAME ELECTRICAL WIRING, CONTROLS, SWITCHES, INDICATORS, AND PROTECTIVE DEVICES.**	**- Level 3**	**42.5 hrs.**
A.	**Types and characteristics of aircraft fuses, circuit breakers and switches.**	**- Level 1**	
B.	**Select and install aircraft electrical switches and wiring to components.**	**- Level 3**	
C.	**Installation requirements and characteristics for aircraft electrical wiring systems and junction boxes.**	**- Level 2**	
D.	**Install electrical terminals, splices and bonding jumpers.**	**- Level 3**	
E.	**Install aircraft electrical wiring in a conduit.**	**- Level 2**	
F.	**Check and connect quick-disconnect plugs and receptacles.**	**- Level 2**	
G.	**Protect electrical emergency switches against accidental actuation.**	**- Level 3**	
H.	**Identify and describe characteristics of aircraft high-tension and low-tension electrical wiring.**	**- Level 2**	
2.	**INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR ALTERNATING CURRENT AND DIRECT CURRENT ELECTRICAL SYSTEMS.**	**- Level 3**	**38.0 hrs.**
A.	**Methods of controlling output current and voltage of compound DC generators.**	**- Level 2**	
B.	**Check, troubleshoot and repair an aircraft dual DC generator electrical system.**	**- Level 3**	
C.	**Methods of providing AC in aircraft having only DC electrical systems.**	**- Level 1**	
D.	**Troubleshoot and repair a DC electrical system supplied by an alternator.**	**- Level 3**	
E.	**Characteristics and advantages of AC aircraft electrical systems.**	**- Level 1**	
F.	**Identify components and operating elements of a 208/114 volt AC aircraft electrical system.**	**- Level 2**	
3.	**REPAIR AIRCRAFT ELECTRICAL SYSTEM COMPONENTS.**	**- Level 2**	**24.5 hrs.**
A.	**Determine causes and effects of switch chatter in solenoid switches and relays.**	**- Level 2**	
B.	**Inspect installation and check circuits of anti-collision and position lights.**	**- Level 2**	
C.	**Inspect, check, and repair landing and taxi light installations.**	**- Level 2**	

D. Inspect, check, service, and repair aircraft interior lighting installations. - Level 2

E. Inspect, check, service, and repair cockpit lights and lighting circuits. - Level 2

F. Inspect and check electrical equipment installations for integrity of mounting and connections. - Level 2

G. Inspect, check, and repair passenger call systems. - Level 1

H. Locate replacement procedures and parts numbers for electrical component replacement. - Level 2

Estimated Instructional Time . . . . . 105.0 hrs.

HYDRAULIC AND PNEUMATIC POWER SYSTEMS

4. IDENTIFY AND SELECT HYDRAULIC FLUIDS. - Level 3 2.0 hrs.

A. Identify and select hydraulic fluids. - Level 3

5. REPAIR HYDRAULIC AND PNEUMATIC POWER SYSTEM COMPONENTS. - Level 2 15.0 hrs.

A. Select and install seals. - Level 2

B. Identify, remove and install a hydraulic selector valve. - Level 2

C. Remove and install pressure regulators. - Level 2

D. Interpret and describe the operation of a pneumatic power system. - Level 2

6. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR HYDRAULIC AND PNEUMATIC POWER SYSTEMS. - Level 3 55.0 hrs.

A. Solve problems involving force, area and pressure. - Level 2

B. Interpret reference information pertaining to operation of a basic hydraulic system. - Level 2

C. Compare constant pressure and open center types of hydraulic systems. - Level 2

D. Inspect and service hydraulic reservoirs. - Level 3

E. Identify and describe the operation of constant and variable displacement hydraulic pumps. - Level 2

F. Check, inspect, remove and install hydraulic power pumps. - Level 3

G. Troubleshoot hydraulic pumps. - Level 3

H. Remove, install, inspect, service and check a hydraulic accumulator. - Level 3

I. Troubleshoot and determine the cause of low, high or fluctuating system hydraulic pressure. - Level 3

J. Inspect, check and service a hydraulically operated flap system. - Level 3

Estimated Instructional Time . . . . . 72.0 hrs.

AIRCRAFT LANDING GEAR SYSTEMS

7. INSPECT, CHECK, SERVICE AND REPAIR LANDING GEAR, RETRACTION SYSTEMS, SHOCK STRUTS, BRAKES, WHEELS, TIRES, AND STEERING SYSTEMS. - Level 3 82.0 hrs.

   A. Clean and store tires. - Level 2

   B. Inspect, demount, repair and reinstall tires on wheels. - Level 3

   C. Remove, inspect, service and reinstall a wheel assembly on the axle. - Level 3

   D. Disassemble, identify components and reassemble mechanical and hydraulic type brake assemblies. - Level 2

   E. Replace a brake actuating cylinder. - Level 3

   F. Adjust clearance on a shoe, multiple-disc and single-disc brake. - Level 3

   G. Inspect, repair and operationally check a master cylinder. - Level 3

   H. Inspect, service and describe the operation of power brake and emergency brake systems. - Level 2

   I. Recognize probable cause of brake malfunctions. - Level 2

   J. Bleed air from a hydraulic brake system. - Level 3

   K. Service, repair and troubleshoot landing gear oleo struts. - Level 2

   L. Describe the operation of an oleo shock strut. - Level 2

   M. Operate, inspect and adjust a retractable landing gear. - Level 3

   N. Check landing gear alignment. - Level 2

   O. Inspect, adjust and service nose and tailwheel steering and damping mechanisms. - Level 3

Estimated Instructional Time . . . . . 82.0 hrs.

POSITION AND WARNING SYSTEMS

8. INSPECT, CHECK, AND SERVICE SPEED- AND TAKEOFF-WARNING SYSTEMS, AND ANTISKID ELECTRICAL BRAKE CONTROLS. - Level 1 11.0 hrs.

   A. Principles of operation, inspection and checks of speed-, stall-, and takeoff-warning systems and antiskid brake control systems. - Level 1

   B. Show simulated operation of antiskid and takeoff-warning systems. - Level 1

9. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR LANDING GEAR POSITION INDICATING AND WARNING SYSTEMS. - Level 3 9.0 hrs.

   A. Inspect, check, troubleshoot, service and repair landing gear position indicating and warning systems. - Level 3

Estimated Instructional Time . . . . . 20.0 hrs.

AIRCRAFT INSTRUMENT SYSTEMS

10. INSTALL INSTRUMENTS. - Level 2 11.0 hrs.

   A. Handling and storing of instruments. - Level 2

   B. Install instrument panels and instruments. - Level 2

11. INSPECT, CHECK, SERVICE, TROUBLESHOOT, AND REPAIR HEADING, SPEED, ALTITUDE, TIME, ATTITUDE, TEMPERATURE, PRESSURE, AND POSITION INDICATING SYSTEMS. - Level 2 9.0 hrs.

   A. Inspect, check, service, troubleshoot and repair instrument systems. - Level 2

Estimated Instructional Time . . . . . 20.0 hrs.

AIRCRAFT FUEL SYSTEMS

12. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR AIRCRAFT FUEL SYSTEMS. - Level 3 13.0 hrs.

   A. Inspect and service fuel tanks. - Level 3

   B. Inspect, check, service, troubleshoot and repair fuel valves and fuel pumps. - Level 3

13. REPAIR AIRCRAFT FUEL SYSTEM COMPONENTS. - Level 2 10.0 hrs.

   A. Interpret information pertaining to repair of fuel system components. - Level 2

14. INSPECT AND REPAIR FUEL QUANTITY INDICATING SYSTEMS. - Level 2 6.0 hrs.

   A. Inspect and troubleshoot fuel quantity indication systems. - Level 2

15. INSPECT, CHECK, AND REPAIR PRESSURE FUELING SYSTEMS. - Level 1 2.0 hrs.

   A. Describe the inspection, checking and repair of pressure fueling systems. - Level 1

16. CHECK AND SERVICE FUEL DUMP SYSTEMS. - Level 1 1.0 hr.

   A. Describe the checking and servicing of a fuel dump system. - Level 1

17. PERFORM FUEL MANAGEMENT, TRANSFER AND DEFUELING. - Level 1 2.0 hrs.

   A. Perform fuel transfer and defueling. - Level 1

18. TROUBLESHOOT, SERVICE, AND REPAIR FLUID PRESSURE AND TEMPERATURE WARNING SYSTEMS. - Level 2 2.0 hrs.

   A. Troubleshoot, service, and repair fuel pressure and temperature warning systems. - Level 2

Estimated Instructional Time . . . . . 36.0 hrs.

COMMUNICATION AND NAVIGATION SYSTEMS

19. INSPECT, CHECK, AND SERVICE AUTOPILOT AND APPROACH CONTROL SYSTEMS. - Level 1 5.0 hrs.

A. Purpose and operating principles of autopilots and approach control systems. - Level 1

20. INSPECT, CHECK, AND SERVICE AIRCRAFT ELECTRONIC COMMUNICATION AND NAVIGATION SYSTEMS. - Level 1 5.0 hrs.

A. Types and installation of aircraft electronic communications and navigation equipment. - Level 1

B. FCC regulations pertaining to two-way radio operation. - Level 1

21. INSPECT AND REPAIR ANTENNA AND ELECTRONIC EQUIPMENT INSTALLATIONS. - Level 2 10.0 hrs.

A. Repair or replace aircraft antennas and related electronic equipment. - Level 2

B. Identify and describe purpose of static dischargers. - Level 2

Estimated Instructional Time . . . . . 20.0 hrs.

CABIN ATMOSPHERE CONTROL SYSTEMS

22. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR HEATING, COOLING, AIR CONDITIONING, AND PRESSURIZATION SYSTEMS. - Level 1 14.0 hrs.

A. The inspection, checking and troubleshooting of aircraft combustion heaters and exhaust-type heat exchangers. - Level 1

B. The checking and troubleshooting of aircraft vapor-cycle and air-cycle cooling systems. - Level 1

C. The functions and principles of operation of aircraft air conditioning. - Level 1

D. The principles of operation and control of cabin pressurization. - Level 1

23. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR OXYGEN SYSTEMS. - Level 2 7.0 hrs.

A. Inspect, check and service oxygen systems. - Level 2

24. REPAIR HEATING, COOLING, AIR CONDITIONING, PRESSURIZATION AND OXYGEN SYSTEM COMPONENTS. - Level 1 9.0 hrs.

A. Identify components of an aircraft combustion heater, freon cooling system, and an air-cycle expansion turbine. - Level 1

B. Repair or replacement procedures for air conditioning and pressurization components. - Level 1

C. Repair or replacement procedures for aircraft oxygen system components. - Level 1

Estimated Instructional Time . . . . . 30 hrs.

ICE AND RAIN CONTROL

25. INSPECT, CHECK, TROUBLESHOOT, SERVICE, AND REPAIR AIRFRAME ICE AND RAIN CONTROL SYSTEMS. - Level 2 12.0 hrs.

A. Principles of installations, operation and checking deicing and anti-icing systems. - Level 1

B. Replace, inspect and check operation of electrically operated air scoop and pitot static or static vent anti-icing. - Level 2

Estimated Instructional Time . . . . . 12.0 hrs.

FIRE PROTECTION SYSTEMS

26. INSPECT, CHECK, AND SERVICE SMOKE AND CARBON MONOXIDE DETECTION SYSTEMS. - Level 1 1.0 hr.

A. Principles of operation of smoke and carbon monoxide detectors. - Level 1

27. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR AIRCRAFT FIRE DETECTION AND EXTINGUISHING SYSTEMS. - Level 3 11.0 hrs.

A. Inspect, check, troubleshoot and repair fire detection systems. - Level 3

B. Select and operate fire extinguishers. - Level 2

C. Check, troubleshoot and repair aircraft built-in fire extinguishing systems. - Level 2

Estimated Instructional Time . . . . 12.0 hrs.

Total Estimated Instructional Time . . . . 409.0 hrs.

Additional Practice and/or Examinations . . . . 10.0 hrs.

Grand Total for Airframe Curriculum ("Structures" and "Systems & Components") . . 750.0 hrs.

AIRCRAFT ELECTRICAL SYSTEMS

1. INSTALL, CHECK, AND SERVICE AIRFRAME ELECTRICAL WIRING, CONTROLS, SWITCHES, INDICATORS AND PROTECTIVE DEVICES.

(EIT = 42.5 hrs., T = 18.5 hrs., L/S = 24 hrs.)
8 segments

(UNIT LEVEL 3)

TYPES AND CHARACTERISTICS OF AIRCRAFT FUSES, CIRCUIT BREAKERS AND SWITCHES.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**

  Written information, AC 43.13–1 or equivalent FAA publication, questions concerning electrical fuses, circuit breakers, and switches.

- **Performance:**

  The student will select answers for twenty questions dealing with the types, purposes, applicability and operation of electrical fuses, circuit breakers, and switches in aircraft.

- **Standard:**

  Select at least fourteen correct answers.

Key Points	*Feedback*
Circuit protection in aircraft.	•Where should the circuit protector be located in the circuit? •What is the primary purpose of the circuit protector? •What wire characteristic determines the size of fuse or circuit breaker to be used?
Circuit breakers.	•Should a circuit breaker open under overload conditions even if held in? •When can automatic reset circuit breakers be used? •Explain the difference between "tripfree" and "nontripfree" circuit breakers.
Circuit breakers used as switches.	•Why is it necessary to have many aircraft circuit breakers serve also as switches? •What procedure should be followed when a circuit breaker kicks open after being closed? •When circuit breakers are opened to clear a circuit for work to be done, what method should be used to warn others not to close those circuit breakers?
Characteristics and uses of fuses.	•Why are fuses generally used only for low voltage circuits or in insulated inserts when protecting higher voltage? •What size fuse should be used to protect # 14 wire? •Describe the types of fuses used in aircraft installations and the purposes for each type.
Replacement of blown fuses.	•What checks should be made before replacing a blown fuse? •Why should the same size and type of fuse always be used for replacements? •Explain why a fuse should not be replaced by a circuit breaker of the same rating unless approved by the aircraft manufacturer.
Switches.	•Where is the nominal rating of a switch usually found?
a. Nominal rating.	•What nominal rated switch would be required for a 12 volt lamp with a continuous load current of 3.6 amperes?
b. Arcing at opening of contacts.	•What causes arcing when contacts are opened on a switch controlling an inductive load? •How can arcing be reduced?
c. Mounting position.	•Why should an "on-off" switch be mounted with the "on" up or forward? •If a switch controls the vertical movement of flaps, doors or gears, how should it be mounted?
d. Mounting security and clearance.	•Why should switches have some means of locking against turning in the hole? •Why is it important to keep adequate clearance between wiring at contacts?

	•May all switches be used interchangeably for DC or AC?
Types of switches.	•Name several types of switches used in aircraft. •Where are micro-switches commonly used? •Why is a relay used in conjunction with a switch for controlling heavy current devices?
Switch designations.	•What is meant by the designations: SPST, DPST, DPDT, and 3PST? •What is meant by NO and NC beside switch terminals? •How does a momentary switch operate?

SELECT AND INSTALL AIRCRAFT ELECTRICAL SWITCHES AND WIRING TO COMPONENTS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
Written information, AC 43.13–1 or equivalent publication, a mock-up with provisions for mounting components and switches, aircraft electrical components, assorted aircraft electrical wire and switches, a DC power supply, an AWG wire gauge and suitable electrical tools.

- Performance:
The student will connect the following aircraft electrical components to the power supply through suitable switches: a retractable landing light with relay controlled filament, a heavy duty motor controlled by a relay, a wing tip light, a reversible motor, and a solenoid type relay for control of external electric power. He will select wire of proper gauge for one-half volt drop, secure wires by clamps and tying, and check each circuit for proper operation.

- Standard:
Switches and electrical wiring will comply with specifications provided. Work performance will meet safety standards and all components will operate properly.

Key Points	*Feedback*
Determine current requirements.	•What kind of meter would be needed to measure the current of a DC component? •If the specifications give the power rating only, how is current calculated?
Determine wire requirements for a specific installation.	•What information is needed to compute required current carrying capacity of a wire for a given installation? •What is the effect on heat dissipation of routing wires together in a bundle? •How does the voltage to be handled effect the wire requirements? •What effect on the wire requirements will use of the airplane structure as a ground return have?
Determine gauge or insulated electrical wire.	•What methods may be used to determine the gauge of solid and stranded electrical wire? •What measurement factor is the AWG wire gauge system based upon? •How is an AWG wire gauge used for stranded wire? •How does some aircraft wire have the gauge printed on it?
Wiring procedures.	•Where are the procedures for wiring to be found? •How are wires routed when near fuel or hydraulic lines? •What are the rules on more than one splice in a bundle? •If chafing occurs or could occur, how should the wire be protected?
Electrical cable chart in AC 43.13–1.	•What is the primary use of the cable chart? •How much current can 30 feet of #16 wire carry for one-half volt maximum drop?
Select aircraft switches.	•Which type of a switch is best for lights, and relay controlled components? •Which type of switch is suitable for a reversible motor?
Mount and connect switches.	•In what position should toggle switches be mounted? •What determines how close a switch may be mounted relative to other components? •What considerations should be taken as to clearance between wire connections?

	•Name several methods of connecting wires to switches, and the advantages and disadvantages of each method.
Installation of open wiring.	•How is open wiring in an airplane secured to structure? •What precautions must be taken when working around open aircraft wiring? •If wires are cut or damaged, where can repair specifications be found? •If several wires are routed together, how should they be secured to each other? •What type of labeling is recommended for aircraft electric wiring?

Activities	*Check Items* Did the student:
Select wires complying with AC 43.13–1 specifications for ½ volt drop, using AWG wire gauge to measure size, connect the following aircraft components to a power supply through suitable switches: a. Retractable landing light with relay controlled filament. b. Heavy duty motor (starter, fuel pump or hydraulic pump type) with control relay. c. Wing tip light. d. Reversible motor. e. Solenoid relay for control of external power.	•Calculate current requirements for each component? •Use electrical cable chart in AC 43.13–1 to determine gauge of wire needed? •Use AWG wire gauge to measure gauge of stranded wire? •Select switches suitable for the components to be controlled? •Drill holes and mount the switches with proper spacing and orientation? •Use an approved method of connecting wires to switches?
Secure wires to mock-up by clamps and tie wires into bundles where practical.	•Plan wire length to permit securing to mock-up by clamps? •Use approved technique in tying wires?
Check for operation of each component.	•Check each component through all phases of its operation?

INSTALLATION REQUIREMENTS AND CHARACTERISTICS FOR AIRCRAFT ELECTRICAL WIRING SYSTEMS AND JUNCTION BOXES.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
Written information, AC 43.13–1 or equivalent publication, questions with multiple choice answers, samples of acceptable and unacceptable aircraft electrical cable terminals of various types.

- **Performance:**
The student will select answers to 16 questions pertaining to the characteristics of single-wire electrical systems, the strength requirements for electrical cable terminals, the purpose, applicability, and use of terminal strips, installation requirements for junction boxes, the criteria for selecting aluminum or copper wire, and the purposes of shielding electrical wiring and equipment. He will inspect 10 electrical terminals and record acceptability of each with reasons for rejection of unacceptable terminals.

- **Standard:**
Select correct answers for at least 12 questions and at least 7 terminals judged correctly with correct reasons where rejected.

Key Points	*Feedback*
Single wire systems.	•What serves as the return path for a single wire system?
a. Ground return path.	•How is the ground return path checked for being adequate?
b. Allowable voltage drop.	•Compute the voltage drop for a # 14 copper cable 40 feet long to carry 6.5 amperes. •Would this cable be adequate for an anti-collision light on a 14 volt system? •Why is a higher voltage drop allowed for intermittent than for continuous operation?
Aluminum vs. copper wire.	•What gauge of aluminum wire will be required to replace #1 gauge copper wire?
Junction boxes.	•What is the smallest gauge aluminum wire that is recommended for aircraft use?

a. Construction and mounting.	•What material should be used for a junction box when fireproofing is necessary? •How should the open side of a junction box face and why?
b. Internal arrangement.	•Why is it important to provide adequate space in a junction box? •What should be provided when electrical clearances are marginal?
c. Wiring.	•What are the requirements for lacing and clamping cables inside a junction box? •How is wiring protected against chafing at entrance openings?
d. Drain holes.	•What maintenance should be provided for drain holes?
Terminal strips.	
a. Barriers.	•What purposes do the barriers serve?
b. Terminal studs.	•Why is it important that studs be checked for tightness and provision to prevent rotation before installing lugs?
c. Maximum number of terminal lugs.	•What is the maximum number of terminals per stud? •How are multiple terminals to be arranged?
d. Terminal hardware.	•Where is a guide to terminal hardware mounting to be found? •What is meant be terminal protection? •Why is it desirable to have at least one spare terminal stud in each strip?
Shielding wiring and equipment.	•What types of circuits require shielding to prevent radiation of interference?
a. Purpose.	•What types of circuits require shielding to prevent picking up interference?
b. Methods.	•Name at least two methods of providing shielding for wires. •How is a metal enclosed unit protected against radiating interference?
Cable terminals.	
a. Wire preparation.	•When stripping insulation, how many strands of wire may be cut on #10 copper wire and on #6 aluminum wire? •Name four disadvantages of using solder for terminal attachment. •What is the purpose of inspection holes in terminal lugs?
b. Cable terminal strength requirements.	•What is the requirement as to tensile strength for cable terminals?
Choice of terminals.	•Why is it important to choose terminals designed for the specific size and kind of cable in use? •When crimped lugs are chosen, what are the special tool requirements? •Why must crimped lugs be used with aluminum cable and what special compound must be used to prevent corrosion?

Activities	*Check Items*
	Did the student:
Inspect ten assorted cable terminals and record acceptability, giving reasons when not acceptable.	•Check for adequate length of wire within the terminal sleeve? •Check for sleeve size being correct for the gauge of the wire? •Check for anti-corrosion paste in aluminum cable lugs? •Check for lug and wire being of same material?

INSTALL ELECTRICAL TERMINALS, SPLICES AND BONDING JUMPERS.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  AC 43.13–1 or equivalent publication, manufacturer's instructions dealing with electrical terminals, assorted samples of aircraft wire and cable, terminals, splices, sleeving, bonding, jumpers, a mock-up with aircraft components requiring bonding, and appropriate tools and equipment for soldering and crimping.
- **Performance:**
  The student will install five soldered and ten crimped terminal lugs on aircraft cable, including two on aluminum cable, splice cables with two soldered splices and three crimped splices, select and install five bonding jumpers for aircraft components which require bonding.

● **Standard:**

At least 80 percent each of the terminals, splices and bonds will meet specifications in AC 43.13–1 or manufacturer's instructions.

Key Points	*Feedback*
Selection of cable terminals.	**•Why must sleeve size be correct for the size of cable being used?**
a. Match cable size and type of metal.	**•On color coded terminals, what does a blue terminal sleeve indicate?** **•Why must the connector be of similar metal to the cable?**
b. Type of lug.	**•What determines the type of lug to be selected?** **•What are the dangers of haphazard selection of types of terminals?** **•Why are ring-tongue terminals almost universally used in aircraft instead of spade terminals?**
c. Size of lug.	**•What determines the sleeve size required at the wire end? Terminal ring hole size?** **•What are the hazards in selecting oversize lugs at the wire end? At the connecting end?**
Wire preparation.	**•How is a wire stripping tool used?** **•Why is a stripping tool better than a knife for wire stripping?**
Methods of attaching to wire or cable.	**•What are the advantages of using crimped lugs instead of solder lugs?** **•What is the importance of using the correct crimping tool for a specific kind of lug?** **•Where can instructions be found for attaching soldered terminals? Crimped terminals?**
Special precautions.	**•Why must special crimping tools be used for aluminum terminals?**
a. Aluminum terminals.	**•Why is a special paste specified for aluminum terminals?**
b. Insulating sleeves.	**•When terminals are not pre-insulated, how is insulating sleeving installed?**
Splicing wire or cable.	**•Why is splicing of wires to be avoided when possible?** **•Why should splices be staggered in a wire bundle?** **•Where are splices permitted?**
Preparation of wires.	**•When stripping cable for splicing, how many wires may be cut or knicked?** **•When insulation of a cable has been damaged, how far back should the cable be stripped?**
Types of splices.	**•What is the difference between a pre-insulated and non-insulated splice connector?** **•What type of tool is necessary to make an acceptable splice, with a splice connector?** **•What must be provided for insulation of non-insulated connectors?** **•Why are solder splices considered as temporary and not recommended?**
Bonding jumpers.	**•What kinds of metal are used for bonding jumper straps?** **•Where are copper straps required?** **•How clean must attachment surfaces be for bonding jumpers?**
Allowable resistance.	**•What is the maximum resistance allowed for any bonding jumper connection?** **•Where is the resistance measured?**
Bonding connection.	**•How is the contact area to be prepared?** **•Where are the instructions found for methods of attachment at bulkheads or aircraft skin?**
Current carrying capacity.	**•How can you determine if the jumper is adequate to carry the current for the unit it is grounding?**

Activities	*Check Items*
	Did the student:
Select and install five solder type terminal lugs on various sizes of copper aircraft wire or cable.	**•Select appropriate terminal lugs?** **•Properly strip and prepare wire or cable?**

Select and install ten crimp type terminal lugs on copper wire and cable and at least two samples of aluminum cable.	•Use suitable solder iron? •Trim the wire and inside of cup before inserting wire? •Select correct crimping tool for each type of crimping? •Strip proper length of insulation? •Check for wire being visible in inspection hole? •Use aluminum lugs for aluminum cable? •Use anti-corrosion compound in each aluminum lug?
Make two soldered cable splices.	•Strip adequate amount of cable to make an acceptable splice? •Solder only in the central portion to maintain flexibility?
Make three splices with crimp type connectors, one of which is non-insulated.	•Use proper crimping tool? •Install adequate insulated sleeving on wire before installing connector? •Tie sleeving at each end after sliding over connector?
Select and install five bonding jumpers to bond selected aircraft components which require bonding.	•Make proper choice of copper or aluminum bonding jumper for each component? •Use more than one jumper where needed to carry required current? •Clean attachment areas properly?

INSTALL AIRCRAFT ELECTRICAL WIRING IN A CONDUIT.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- **Given:**
  Written instructions, a mock-up or aircraft with a section of conduit having bends and terminating in junction boxes at each end, with damaged wiring installed through the conduit and connected to terminals at each end and a circuit diagram for the conduit wiring.

- **Performance:**
  The student will remove the damaged wiring from the conduit, and clean the conduit as necessary. He will prepare and install wiring through the conduit and connect the cables to the terminals at each end to complete the circuits shown in the diagram provided.

- **Standard:**
  The cables will be installed in accordance with the instructions provided and each circuit will show correct continuity in accordance with the diagram.

Key Points	*Feedback*
Removal of damaged wiring from conduit.	•After disconnecting wiring, how should the cables be pulled out of the conduit? •What provision should be made for a pull wire or "snake" to pull the replacement wiring through the conduit?
Cleaning of conduit.	•Why may the conduit need to be cleaned after the old wiring has been removed? •How can the inside of the conduit be cleaned?
Preparing wiring for pulling through conduit.	•How many wires or cables should be pulled through at a time? •How are the wires prepared to aid in easing of pulling through? •When should terminals be installed on the wiring?
Check for correct circuit continuity.	•What equipment may be used to check the circuit continuity?

Activities	*Check Items*
	Did the student:
Remove damaged wiring from a conduit which has at least two bends.	•Disconnect all wires before pulling from conduit? •Pull through a "snake" wire or rope attached to one of the wires being removed?
Prepare replacement wiring for installation.	•Tie "snake" securely to all wires to be pulled through? •Paraffin or wax the wires for ease of pulling through?

	•Cut all wiring with sufficient length to allow for installing terminals and making neat connections at terminal strips?
Use "snake" to pull wiring through the conduit.	•Pull all wires through conduit together?
Install terminals on wires and connect to terminal strips in junction boxes.	•Use proper terminals lugs and tools for making terminals? •Route all wires for a neat installation? •Connect all wiring in accordance with circuit diagrams?
Make continuity check of each circuit for being correctly connected.	•Use suitable test equipment for making continuity checks?

CHECK AND CONNECT QUICK-DISCONNECT PLUGS AND RECEPTACLES.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
Written information, AC 43.13–1 or equivalent publication, questions with multiple choice answers concerning the use of quick-disconnect plugs, samples of aircraft connector plugs and mating receptacles, some of which have defective pins or sockets, tools or test equipment for checking pins and sockets.

- **Performance:**
The student will select answers for 14 questions dealing with the use of aircraft electrical quick disconnect plugs and receptacles, checking pins and sockets, tightening and securing or safetying quick-disconnect connectors, and purposes of various types of inserts, seals, sleeves and grommets used in plugs and receptacles. He will check pins and sockets in connectors and locate five which are defective, write down reasons for rejections, select five mating plugs and receptacles and connect each pair together, safetying two at tie points provided.

- **Standard:**
Select correct answers for ten questions. Four defective pins or sockets will be correctly located and have acceptable reasons given, and all mated connectors will be correctly selected and secured. Safeties installed will meet return-to-flight standards.

Key Points	*Feedback*
Quick-disconnect connector terminology.	•What determines which is the plug and which is the receptacle?
a. Plugs and receptacles.	•What determines whether a plug or receptacle is male or female?
b. Male and female. c. Pins and sockets.	•Explain the difference between plugs and receptacles and pins and sockets in connectors. •What is the difference between threaded and twist-lock connectors?
Classes of connectors as given in AC 43.13–1.	•Name some aircraft uses of quick-disconnect connectors and class of connector required for each. •Explain purposes for having rubber or neoprene inserts around the pins and sockets. •How do connectors for thermocouple wiring differ from other connectors?
Wire connection. a. Solder.	•Compare the advantages of soldered and crimped wire connections and connectors.
b. Crimped.	•What special tools are required for crimped type connectors?
Pin and socket locator identification letters or numbers.	•By what methods are pin and socket locator letters or numbers provided on plugs and receptacles? •What locators are unreadable, how can wire numbers be used to locate desired pins or sockets?
Causes for malfunctions:	•What is the hazard of too frequent disassembly of connectors for inspection?
a. Wires frayed or broken.	•What fault is usually indicated by an arced or burnt pin?
b. Pins bent, broken off, or loose.	•What precautions must be taken when straightening bent pins?
c. Sockets enlarged or corroded.	•What causes a socket to become enlarged? •If corrosion is present, on a pin, what should be done about its mating socket?

d. Worn or corroded pins.	•What is the proper repair procedure for a pin worn beyond limits? •How should corroded pins be cared for?
Wire protection.	•What causes frayed or broken wires at the shell inlet? •What should be provided to protect the wires at the inlet? At the pin or socket connection?
Methods of securing connectors.	•How should a threaded connected be tightened? How tight? •What should be provided to assure a threaded connector not vibrating loose? •How are twist lock or bayonet type connectors secured? •How should a safety wire be installed?

Activities	*Check Items*
	Did the student:
Check pins and sockets in quick-disconnect connectors and write down reasons for each pin or socket judged unacceptable.	•Use pin and socket checkers? •Look for corrosion, bent pins and enlarged sockets? •Check for pins being broken off?
Select mating plugs and receptacles and assemble each pair, tightening connectors properly and safetying at least two connectors which have tie points provided.	•Use pin layout, polarizing slots, AN or part numbers, and size to aid in matching pairs? •Tighten by hand and finger tight only? •Install safety wire so as to hold against unscrewing of the safetied element?

PROTECT ELECTRICAL EMERGENCY SWITCHES AGAINST ACCIDENTAL ACTUATION.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- **Given:**
  Written information, a mock-up or airplane with guarded and safetied type switches for electrically controlled emergency systems.
- **Performance:**
  The student will close three guarded switches, two of which have guards safetied open and three non-guarded switches, safetied open. He will reset the guards on each guarded switch and install safety wires on the two guards which were previously safetied. He will re-safety the three non-guarded switches, using breakaway wire for all safeties.
- **Standard:**
  Each switch will be reset correctly and each guard will be reset properly. All five safeties will be correctly made with approved wire.

Key Points	*Feedback*
Guarded switches.	•How can a guarded switch be checked for being in the off position?
a. Spring loaded type.	•With a spring loaded guard, what should be the possibility of forcing the switch "on" without lifting the guard first?
b. Safetied guards.	•Why is a safety used when the guard already provides protection against accidental actuation?
Non-guarded safetied switches.	•How does a pull-to-operate switch prevent accidental actuation? •Why should such a switch also be safetied? •What provision is made for installing safety wire on either pull-to-operate or regular toggle switches? •How can a switch without such provision be safetied?

Activities	*Check Items*
	Did the student:
Move guarded and safetied switches for emergency circuits to the closed position.	•Make sure power was off to the emergency circuits before closing the switches?
Open the switches and reset guards on guarded switches.	•Make sure each switch was in the fully open position? •Make sure each guard was fully in place?
Install break-away wire safeties on all switches having provision for safetying.	•Install each safety with proper twists between tie points and sufficient additional twists after structure tie? •Use suitable tool to twist safety wire?

IDENTIFY AND DESCRIBE CHARACTERISTICS OF AIRCRAFT HIGH-TENSION AND LOW-TENSION ELECTRICAL WIRING.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  Samples of aircraft high-tension cables for spark plug leads, and for ignitor leads, low-tension cables for 12 volt to 208 volt electrical systems wiring, low-tension ignition primary leads and thermocouple leads, a chart showing kinds of wire and characteristics of each, and manufacturer's wire and cable information.

- Performance:
  The student will select five samples of high-tension wire and ten samples of low-tension wire including thermocouple leads. Using the chart as a guide, he will prepare a label for each sample giving description of wire type and characteristics for each type.

- Standard:
  At least three kinds of high-tension wire and seven kinds of low tension wire will be correctly labeled. Characteristics will be correctly described for at least ten types of wire.

Key Points	*Feedback*
Ignition high-tension wiring.	• What are the two principal purposes of shielding? • What is corona and what does it indicate? • How can radio interference be reduced when unshielded cable is used? • Why are ignitor leads usually larger in diameter and double shielded?
Low-tension wiring. a. Insulation. b. Shielding.	• What are the insulation requirements for 14/28 volt aircraft wiring? • Compare the insulation needs of 208 volt 3 phase cable with high-tension cable. • What is the primary purpose of shielding for AC cable?
Low-tension ignition wiring.	• What is the reason that low-tension ignition primary wires need to be better insulated than electrical system wires?
Thermocouple wiring	• What special kinds of metal are used for thermocouple leads? • What level of voltage and current is carried by thermocouple leads? • What is the normal repair procedure for a broken thermocouple wire?

Activities	*Check Items*
	Did the student:
Identify samples of high-tension and low-tension aircraft cable, including thermocouple wires, by use of a chart giving wire descriptions and characteristics and prepare a label for each sample, giving type and general characteristics.	• Use description of cable and shielding to identify type of wire for each sample? • Use wire manufacturer's information to assist in identification? • Identify thermocouple wires by types of metal used?

2. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR ALTERNATING CURRENT AND DIRECT CURRENT ELECTRICAL SYSTEMS. (EIT = 38 hrs., T = 19.5 hrs., L/S = 18.5 hrs.) 6 segments

(UNIT LEVEL 3)

METHODS OF CONTROLLING OUTPUT CURRENT AND VOLTAGE OF COMPOUND DC GENERATORS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Written information, schematic diagrams, unlabeled diagrams, and questions with multiple choice answers.

- Performance:
  The student will select answers to 20 questions concerning methods for controlling single and multiple generator DC aircraft electrical systems. He will select answers concerning vibrator and carbon pile voltage regulators, regulation of voltage and current in single and multiple generator systems, reverse current cutout relays and effects of sticking points in such relays, over-voltage and overload protection. On unlabeled diagrams of single and two generator DC aircraft electrical systems, he will show by labels, or arrows, how voltage and current are controlled in compound DC generator systems and how equalization of load is accomplished in an aircraft electrical system having two DC generators.

- **Standard:**
  Select correct answers for at least 15 questions and at least 75 percent of diagram labels will be accurate.

Key Points	*Feedback*
Generator control systems.	• What is the primary function of a generator control system?
Voltage regulation by field current control.	• Why is the field current varied for voltage regulation? • How is constant voltage maintained when the RPM of the generator increases? • When load increases?
a. Vibrator type voltage regulators.	• How does a vibrator type voltage regulator provide field current control? • What maintains the desired voltage and how is it adjusted?
b. Carbon pile voltage regulators.	• How does a carbon pile voltage regulator provide field current control? • What maintains the desired voltage and how is it adjusted?
Output current control.	• What normal limiting factor prevents an excessive generator load?
a. Reverse current cutout relay.	• What are the basic functions of the reverse current cutout relay? • What are the probable results of sticking points in the relay? • Explain the effects of a failure of the points to close.
b. Overload protection current limiter or circuit breaker.	• What are the probable causes for opening of a current limiter or circuit breaker in the output circuit of a generator? • Explain how equalization aids in overload protection in multiple generator systems.
Overvoltage protection.	• When the overvoltage relay actuates the field excitation relay, what effect does this have on the output voltage?
Equalization.	• Why is some method of load equalization needed in multiple generator systems? • Explain how adjustment is accomplished for the equalizing circuit.

Activities	*Check Items*
On an unlabeled diagram for a single compound DC generator aircraft electrical system, show by labels, polarity marks and arrows where needed, how voltage and current are controlled.	• Label all major components? • Label and show polarity for all inductive and resistance elements? • Show by arrows the direction of current flow?
On an unlabeled diagram of an aircraft electrical system with 2 DC generators, show by labels, polarity marks and arrows, how the load is equalized between the 2 generators.	• Show by labels and polarity marks how equalization voltage is provided? • Show the relationship of field current to load share for each generator?

CHECK, TROUBLESHOOT AND REPAIR AN AIRCRAFT DUAL DC GENERATOR ELECTRICAL SYSTEM.

(SEGMENT B, LEVEL 3)

Student Performance Goal:

- **Given:**
  Written information, manufacturer's instruction manual, an aircraft or mock-up with an operative DC dual generator system, appropriate tools and test equipment.

- **Performance:**
  The student will read and record voltage and output current for each generator at various RPM, adjust the voltage regulators, adjust load equalization, flash a generator field, check the operation of the reverse current cutout relays, locate and correct at least three open or short circuit malfunctions introduced by the instructor.

- **Standard:**
  All procedures will be performed in accordance with the information and specifications provided.

Key Points	*Feedback*
Compound DC generator electrical system components.	• Compare single and multiple generator systems as to components required.

	•How many wires are normally connected to a compound DC generator?
Voltage regulators.	•Why are all line adjustments usually confined to voltage regulation? •Why is it preferable to use a test voltmeter when adjusting a voltage regulator instead of the airplane voltmeter (if provided)? •Why should a generator system be operated for a specified time before adjustment is made?
Equalizing circuit and adjustment.	•In multiple generator systems, why must all generators be operating and connected to the combined electrical load before equalizing adjustments are made? •Why should each voltage regulator be checked for being set to the same voltage before equalizing adjustments are made?
Effect of residual or stray magnetism in a generator field.	•What will be the effect on generator operation of a field magnetized in reverse polarity?
Flashing the field.	•What is accomplished by flashing the field of a generator? •When is it necessary to flash the field? •How is a battery connected to flash the field? •What is provided in some regulators to keep the field polarized properly and reduce the need for flashing?
Reverse current cutout relays.	•What is the purpose of the reverse current cutout relay? •When does it operate? •What are probable results if points fail to open or close?
Voltage and current indication.	•When a voltmeter is provided, what specific voltage is it indicating? •When an ammeter is provided, what specific current is being measured? •If an indicator light is substituted for meters, how is a voltage reading obtained for voltage regulator adjustment?

Effects of open and short circuits.	
a. Generator field circuit.	•What will be the effect on output current of an open circuit to the generator field? A short circuit? •Why is the field circuit normally protected by a circuit breaker?
b. Reverse current relay circuit.	•What happens to a generator when reverse current flows into it?
c. Equalizing circuits.	•On a system with load or current meters, what will be the indications of a shorted and open equalizing circuit?

Activities	*Check Items*
	Did the student:
In an operating dual DC aircraft generator control system.	•Provide adequate warmup time?
a. Check voltage of each generator output.	•Use test voltmeter? •Check system voltmeter against test voltmeter (if system voltmeter is provided)? •Use adequate RPM? •Read meters accurately?
b. Check output current of each generator while operating in parallel.	•Use test ammeter? •Check system load meter or ammeter against test ammeter (when system meter is provided)?
c. Check output of each generator separately.	•Reduce load, if necessary to not exceed rating of one generator? •Cut off the generator not being tested?
d. Adjust voltage regulators.	•Use test voltmeter? •Follow procedures provided?
e. Adjust equalization.	•Make sure both generators are operating at same voltage? •Adjust for equal load on each generator while operating at same RPM?
Use test equipment and troubleshooting procedures to locate three different open or short circuit malfunctions introduced by the instructor.	•Use diagrams and instruction manual to assist in locating troubles? •Use continuity check to aid in locating malfunctions?

METHODS OF PROVIDING AC IN AIRCRAFT HAVING ONLY DC ELECTRICAL SYSTEMS.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information, schematic diagrams, questions with multiple choice answers.

- **Performance:**
  The student will select answers for 14 questions concerning methods of providing AC in aircraft that have DC electrical systems, and the operating principles and characteristics of rotating and solid state inverters.

- **Standard:**
  Select correct answers for at least 10 questions.

Key Points	*Feedback*
Common needs for AC in aircraft having only a DC electrical system.	• Why is AC more suitable for some instruments, communication, and navigation equipment? • What frequency is commonly used for aircraft AC electrical needs? • What are some advantages of three-phase over single phase AC?
Methods of converting DC to AC in aircraft.	• What are the differences between an inverter, a converter, and a motor generator? • Why is an inverter the most suitable method of obtaining AC from a basic DC system?
Operating principles of rotary inverters.	• What is the advantage of having the motor and generator armatures on a common shaft? • How is the AC voltage controlled?
Heat dissipation for inverters.	• Why is some form of ventilation vital for all inverters? • How does the efficiency of the inverter relate to the amount of heat to be dissipated?
Operating principles of solid state inverters.	• What is a solid state inverter? • Compare the output of an oscillator with that of an alternator? • How can the output voltage be controlled or regulated in a solid state inverter?
Frequency control for inverters.	• How is the frequency controlled in a rotary inverter? • How is the frequency controlled in a solid state inverter? • How can the frequency be measured?
Special uses of AC in aircraft.	• What is the electrical need if fluorescent lights are used? • What type of electrical power is needed for synchro instruments, gyro compass systems and servo motors?
Use of alternators on one or more engines to furnish AC.	• What type of AC will be obtained from an alternator on an aircraft engine without any regulation of voltage or frequency? • Why is this acceptable as a power source for resistance type windshield anti-icing?

TROUBLESHOOT AND REPAIR A DC ELECTRICAL SYSTEM SUPPLIED BY AN ALTERNATOR.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  Manufacturer's service manual and schematic diagrams, an aircraft or mock-up with an operative DC electrical system supplied by an alternator with built-in rectifiers, suitable tools and test equipment.

- **Performance:**
  The student will troubleshoot and repair a DC aircraft electrical system. He will locate and correct five malfunctions introduced by the instructor, locating and correcting each malfunction before the next is introduced.

- **Standard:**
  Four malfunctions will be located and corrected without assistance from the instructor.

Key Points	*Feedback*
Use of alternators for DC aircraft electrical systems.	• Name several advantages of alternators over DC generators.

	•What are the advantages of using three-phase alternators where a large output current is required? •What is the approximate AC voltage from an alternator to supply a 12/14 volt DC system?
Field excitation control for voltage regulation.	•Name at least two methods of obtaining field excitation voltage for the alternator. •Why are solid state regulators preferable to vibrator or carbon pile regulators? •What circuit is regulated to maintain the desired output DC voltage?
Rectification of the AC to obtain DC output.	•What developments in rectifier design have led to the use of alternators with built-in rectification? •Why is a bridge circuit used for the silicon diodes in aircraft alternators? •What is the purpose of a capacitor across the DC output? •What is a likely result if this capacitor becomes open or disconnected?
Overvoltage and overload protection.	•Why is some form of overvoltage protection necessary? •Describe one method of providing overvoltage protection. •How much of an overload can an alternator handle without danger? •What type of protection is provided against excessive overloads? •If this is a circuit breaker or current limiter, which can be reset, what precaution should be taken before resetting?

Activities	*Check Items*
	Did the student:
In an operative DC electrical system supplied by an alternator, troubleshoot and correct five different malfunctions introduced by the instructor.	•Use the manufacturer's manual for troubleshooting information? •Use appropriate test equipment to aid in troubleshooting? •Check operation of the full system after correcting each malfunction?

CHARACTERISTICS AND ADVANTAGES OF AC AIRCRAFT ELECTRICAL SYSTEMS.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information, schematic diagrams, questions with multiple choice answers concerning AC electrical systems and components.

- **Performance:**
  The student will select answers to 20 questions dealing with the advantages of AC for aircraft electrical power systems, how frequency of an AC generator is determined, reasons for using 400 cycle AC in aircraft, operating principles and characteristics of transformers and rectifiers, and their use for obtaining DC for battery charging and other DC needs.

- **Standard:**
  Select correct answers for at least 14 questions.

Key Points	*Feedback*
Advantages of AC electrical systems in aircraft.	•Name several factors that result in weight saving by use of an AC system. •What are some maintenance advantages? Some disadvantages? •Why are voltages as high as 115 to 208 volts used rather than 14 to 28 volts? •Why is it easier and more practical to convert 115/208 volt AC to 14 or 28 volt DC than to reverse the process?
Determining frequency of AC generator output.	•What is the frequency of a single phase AC generator with 12 poles which rotates at 4000 RPM? •What type of indicator can be used to test the frequency of an operating AC generator? •What method is used to maintain a constant frequency for the output of aircraft AC generators?

Use of 400 cycle AC for aircraft.	•What are the advantages of using 400 cycle AC instead of 60 cycle? •Which types of electrical equipment can be used on either 400 or 60 cycle AC? •Which types cannot?
Transformer principles.	•What is the principle of operation of a transformer? •Why are 400 cycle transformers lighter and smaller than those for 60 cycle AC?
Transformer-rectifier units.	•For heavy duty DC loads, what is the advantage in transmitting AC at full voltage to the load, then stepping the voltage down and rectifying to DC at the load? •How can a transformer and rectifier be used to charge the battery in aircraft using only AC generators? •Why are DC motors and relays used in many applications instead of AC motors?

IDENTIFY COMPONENTS AND OPERATING ELEMENTS OF A 208/115 VOLT AC AIRCRAFT ELECTRICAL SYSTEM.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
  Manufacturer's instruction manual or equivalent written information, schematic and block diagrams without labels, dealing with a 208/115 volt, 3 phase aircraft AC electrical system and constant speed drive for one generator, and label cards for major components and certain operating elements of the AC electrical system and the constant speed drive.

- **Performance:**
  The student will insert an identifying label adjacent to each of 20 components or operating elements shown in the diagrams of the AC electrical system and the constant speed drive.

- **Standard:**
  Correctly associate at least 16 labels with the component or operating element to which each applies.

Key Points	*Feedback*
AC generator design and arrangement.	•What method is used to provide starting voltage for the exciter field? •Why is the exciter field stationary and its armature rotating? •What is provided to convert the exciter output current to DC?
Exciter provides current for rotating main field.	•How is the DC supplied to the main field? •What is the advantage of having the main armature stationary?
Fixed main armature provides three-phase output.	•How is three-phase output obtained? •What is the voltage between any two arms of the wye windings? •What is the voltage between any arm of the wye windings and the common center terminals? •Why must some form of cooling for the generator be continuously maintained?
Splined coupling shaft to the C. S. D. unit.	•What provision is made in the spline shaft to cause it to shear in case of generator seizure?
Constant speed drive.	•Why is a C. S. D. unit needed? •Why is the frequency of the generator output dependent on the C. S. D.?
Principle of operation of the C. S. D. unit.	•What type of mechanical drive is used in most C. S. D. units? •Describe how the hydraulic unit can be either a pump or a motor as needed. •How much of the actual drive work is done by the hydraulic unit?
Oil reservoir and cooler.	•Where does the C. S. D. obtain oil for lubrication? •What is the purpose of the scavenge pump? •At what point is the oil temperature sensed?
C. S. D. governor.	•What type of governor is used to control the RPM of the C. S. D. output? •What type of vernier control is provided for the governor?

Generator control panel.	• What are the functions of the generator control panel? • What is the advantage of having a single control panel incorporate all generator control functions rather than several separate units?
Annunciator panel in flight compartment.	• Why is an indicator or annunciator panel for the control unit provided in the cockpit? • Name several faults that can be sensed by the fault detection functions? • What will be the cockpit indication when a fault is sensed?
Busses and bus tie relays.	• What is the reason for a number of separate busses? • Why is 26 volt AC needed in addition to 115 volt AC? • How is the 28 volt DC obtained from the 208/115 volt AC?
Meter, switches and indicator lights in cockpit.	• What provisions are made in the cockpit for control and monitoring of the various buses? • Can each generator be manually controlled from the cockpit?
External power.	• Why should external power be "off" before the connector is plugged into the airplane? • Why is a separate bus provided for the battery DC?
Battery bus.	• How is the battery connected to the airplane 28 volt DC buses? • What provision is made for keeping the battery charged?

Activities	*Check Items* Did the student:
Insert identification label cards in blank spaces on schematic and block diagrams of a 208/115 volt AC aircraft electrical system and a constant speed drive to identify each major component or operating element.	• Use the manual or information provided to aid him in selecting correct labels?

3. REPAIR AIRCRAFT ELECTRICAL SYSTEM COMPONENTS. (EIT = 24.5 hrs., T = 13.0 hrs., L/S = 11.5 hrs.) 8 segments

(UNIT LEVEL 2)

DETERMINE CAUSES AND EFFECTS OF SWITCH CHATTER IN SOLENOID SWITCHES AND RELAYS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information, samples of solenoid switches and relays which have been subjected to switch chatter to varying degrees of severity.
- **Performance:**
  The student will inspect ten solenoid switches and relays which have been damaged to varying degrees by switch chatter arcing, list the probable causes, extent of damage and repair ability for each sample.
- **Standard:**
  At least seven samples will be correctly listed as to cause and extent of damage and repairability.

Key Points	*Feedback*
Solenoid chatter causes.	• Name three causes for chatter. • Why will low voltage or over tensioned spring cause similar chatter?
Operational symptoms of solenoid chatter.	• What are some symptoms of solenoid chatter in an airplane starter circuit? • What will be the cockpit indications of a chattering battery contactor relay?
Effects of solenoid chatter.	• What type of damage to the contact surfaces usually results from chatter? • What causes the contacts to fail to open after excessive contact chatter?
Preventative or corrective action.	• Why is a capacitor often recommended to reduce arcing or pitting of contacts? • Where can information be found for proper adjustment of solenoid spring tension? • Which electrical connections should be inspected when erratic voltage is suspected?

Activities	*Check Items* Did the student:
Inspect samples of solenoid switches and relays with damage from contact chatter. List extent of damage probable cause of chatter and repairability for each sample.	•Check type of damage? •Check for incorrect spring tension? •Check extent of pitted contacts? •Check for improper alignment or seating of contacts? •Check integrity of the electrical connection?

INSPECT INSTALLATION AND CHECK CIRCUITS OF ANTI-COLLISION AND POSITION LIGHTS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  An aircraft or mock-up with anti-collision and navigation position lights installed and operative, manufacturer's information, AC 43.13–2 or equivalent publication.

- **Performance:**
  The student will inspect the installation and check the circuits of the anti-collision and position lights as installed on the aircraft or mock-up. He will make a list of five installation or circuit requirements for each type of light and note whether each requirements listed has been satisfied in the installation inspected.

- **Standard:**
  Correct listing of ten requirements and correct decisions noted for eight requirements.

Key Points	*Feedback*
Anti-collision lights.	•What kind of light is to be used for anti-collision warning?
Crew vision requirements.	•What is required in respect to avoiding interference with flight crew vision?
Placards.	•What warning should be displayed on placard in anti-collision light installations? •Where should the placards be located?
Location of lights.	•What are the locations where rotating beacons may be installed?
Position lights for navigation.	•What three locations on the aircraft must have position lights?
Viewing angles.	•What angles of visibility are required for wing lights? •For tail lights?
Colors and intensity.	•What color is specified for each location? •What light intensity is required?
Electrical circuit requirements.	•What is the maximum allowable voltage drop for this circuit (if a 12 volt system)? •How do you determine proper wire and fuse sizes? •How should the control switches be located with respect to their on/off positions? •What provisions should be made to properly ground the lights?

Activities	*Check Items* Did the student:
Inspect and check anti-collision and position light installations and circuits for meeting FAA requirements.	•Check viewing angles of all lights? •Check for visual indication of cockpit of wing light operation? •Check for installation of placards required? •Make sure crew vision requirements are met? •Inspect for installation of proper ground connections?

INSPECT, CHECK, AND REPAIR LANDING AND TAXI LIGHT INSTALLATIONS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Manufacturer's service information, an aircraft or mock-up with retractable prefocused landing lights and a prefocused taxi light installed and operable, replacement prefocused lamps, suitable tools and test equipment.

- **Performance:**
  The student will inspect and check the installation, circuit, and operation of landing lights, including extension and retraction of the lights. He will replace a prefocused landing light lamp and adjust the extension limit switches. He will inspect, check, and repair a taxi light installation by replacing a lamp.

- Standard:
All work will be accomplished to return-to-service level in accordance with information provided.

Key Points	*Feedback*
Purposes and uses of landing lights.	•For what purposes besides landing are landing lights used? •Why are landing lights often made extendable (and retractable)? •What types of electrical control switches are provided in the cockpit for retractable landing light operations?
Repair procedures for retractable landing lights.	•Why is it important that the same type of lamp is used for replacement as was called for by the manufacturer? •Where prefocused lamps are used, how is the position of the lamp in the mounting determined? •How can the maximum extension permitted be determined and obtained?
Repair procedures for fixed landing lights.	•How are fixed landing lights adjusted for beam angle horizontally and vertically? •If the beam size can be adjusted, where will instructions be found for doing this?
Taxi lights.	•What is the primary purpose of a taxi light? •Where are taxi lights usually mounted on the aircraft? •What adjustments can normally be made for taxi lights?

Activities	*Check Items*
	Did the student:
Inspect installations of retractable landing lights and a taxi light on an aircraft or mock-up. Check operation and compliance of beams to specification for each type of light. Replace lamps in retractable landing lights and in a taxi light.	•Use a voltohmmeter to check for adequate voltage and for grounding integrity? •Make sure landing lights travel through the full specified arc of extension and retraction? •Use the correct lamp type and rating for each light? •Install lamps in the correct position in the mountings?
Adjust limit switches on landing lights for specified degree of extension.	•Use a protractor or beam angle jig to check beam angles and widths?

INSPECT, CHECK, SERVICE, AND REPAIR AIRCRAFT INTERIOR LIGHTING INSTALLATIONS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
Written information, manufacturer's manuals, a mock-up of several types of aircraft interior lighting, including DC dome and reading lights, AC series type cabin lights, and a fluorescent light, suitable tools and test equipment, replacement lamps.

- Performance:
The student will draw circuit diagrams for the following aircraft lighting systems: A DC cabin light system with three dome lights, four seat reading lights, and an entry light; an AC cabin light system with 28 volt lights in a series-parallel circuit for 115 volts AC; and a fluorescent type cabin lighting system. He will inspect, check voltages and replace lamps in a DC dome light, a seat reading light, an AC series light system, and a fluorescent light fixture on an operative mock-up.

- Standard:
At least two of the three circuit diagrams will be correctly drawn in accordance with information provided. Inspection, checking, and lamp replacement will be at a return-to-service level and in accordance with manufacturer's manuals provided.

Key Points	*Feedback*
DC cabin lighting systems.	•Why are DC lighting systems wired in parallel for all lights? •Why should replacement lamps never exceed the wattage rating specified for each light? •How can cabin lights be wired to permit switch control from two or more locations?
Seat reading lights.	•Why is it desirable to provide an individual light and control switch for each seat? •How are reading lights focused?

	•How is ventillation usually provided for reading lights?
Entry lights and compartment lights.	•Why are most entry and compartment lights of lower power than cabin dome lights? •What would be a likely cause of a burnt plastic cover on an entry light?
AC series-parallel cabin lighting.	•When 28 volt lamps are used in series-parallel on a 115 volt AC system for cabin lighting, how are they connected? •If four lamps were out, how would the bad lamp or lamps be most easily located? •Why is there a serious shock hazard when replacing AC series-parallel lamps? •What is the reason all lamps used in such a system should be of the same type andrating?
Fluorescent lighting.	•Why does fluorescent lighting require at least 115 volts AC? •How can 115 volts AC be provided in a 12 or 24 volt DC operated aircraft? •Why are ballasts and starters needed for most fluorescent lighting systems? •How can radio interference from fluorescent lights be reduced?

Activities	*Check Items* Did the student:
On an operating mock-up with various types of aircraft lighting systems, the student will inspect, check, and make lamp replacements for a DC cabin lighting system, seat reading lights, an AC series-parallel cabin lighting system, and a fluorescent light installation.	•Use a voltohmmeter to check voltages and continuity where needed? •Turn power off when checking continuity? •Use only specified types of lamps for replacement? •Use proper caution when working on 115 volt AC lighting?

INSPECT, CHECK, SERVICE, AND REPAIR COCKPIT LIGHTS AND LIGHTING CIRCUITS.

(SEGMENT E, LEVEL 2)

Student Performance Goal

● Given:
Written information, manufacturer's manuals, a mock-up or aircraft with typical cockpit lighting, replacement lamps or assemblies, and suitable tools and test equipment.

● Performance:
The student will inspect, check, and make lamp or light assembly replacements for ten different types of cockpit or instrument lighting installations. He will replace an inoperative overhead or panel type cockpit lighting fixture and repair an instrument light circuit in which the instructor has introduced an open connection.

● Standard:
At least eight lighting installations will be properly inspected, checked for proper operation, and lamp replacement correctly made. Repairs to overhead or panel light and instrument light circuit will be accomplished to return-to-service standards.

Key Points	*Feedback*
Types of overhead and panel lighting installations for cockpit lighting.	•Why are most cockpit lighting systems provided with both white and red lights in most locations? •What methods are used for dimming lights in the cockpit? •Why are many small lights used rather than a few larger lights? •Why are fluorescent or neon lamps seldom used for cockpit lighting?
Instrument lighting.	•Why are most instruments lighted with indirect lighting? •Why are several small lights used in instrument lighting rather than a single larger light? •Describe instrument panel edge lighting and integral lighting for annunciator panels?
Servicing procedures for cockpit lighting.	•What is the importance of replacing instrument lights with the same type of lamps or light assemblies? •Why should any lamp which appears dark colored or blacken be replaced even though it still operates? •When checking voltage and continuity for cockpit lights, why should initial checks be ma with dimmers at full brightness? •How can dimmer operation be checked in bright daylight?

	•When all lights in a panel flicker or dim together, what fault should be suspected?

Activities	*Check Items*
	Did the student:
Inspect, check, and replace lamp or light assembly in ten different types of cockpit or instrument lighting installations.	•Inspect wire, sockets, lamp security, and mounting? •Check operation with and without dimming? •Use correct replacement lamp for each unit?
Replace an inoperative overhead or panel type cockpit lighting fixture installation and an instrument lighting circuit in which an open circuit has been introduced by the instructor.	•Inspect and check for broken wire or loose connections? •Check operation after work was completed? •Use a voltohmmeter or test light to locate cause of trouble?

INSPECT AND CHECK ELECTRICAL EQUIPMENT INSTALLATIONS FOR INTEGRITY OF MOUNTING AND CONNECTIONS.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
Manufacturer's service manual or equivalent written information concerning shock mounting of electrical equipment, quick disconnect plug-in connectors for electrical units, and methods of securing equipment on shelves or racks, an aircraft or mock-up with electrical units mounted on shelves or racks.

- Performance:
The student will inspect electrical equipment installations on shelves or racks for security of lock-in, integrity of shock mounting, and clearance from other equipment. He will check the plug-in connectors for proper mating and adequate engagement and assure that all requirements for cooling or ventillation are satisfied.

- Standard:
Procedures for inspecting and checking the installations will be conformed to in accordance with information provided.

Key Points	*Feedback*
Electrical equipment installations in bays or compartments.	•Why is it common practice to mount associated electrical equipment together in a bay or compartment? •Why are plug-in connectors preferable to terminal strip connections for electrical units mounted on shelves? •Name several methods used to lock electric units on shelves or in racks?
Shock mounting.	•Why is some method of shock mounting needed for most electrical plug-in units? •What purposes do the shock mounts serve? •How important is the correct amount of shock absorption? •Should the shock mounts be on the racks or the units? Why?
Plug-in quick disconnect connectors.	•What is the importance of accurate and easy mating of the plug and receptacle? •Why are male receptacles usually installed in the plug-in units rather than female types? •How can full engagement be determined for a rack mounted plug-in unit? •Why is care necessary when plugging such units in?
Ventillation and cooling for shelf or rack mounted units.	•Why is adequate ventillation necessary for most electrical units? •How is forced draft cooling provided when needed? •How important is it that the cooling always operates when electrical power is operating in the cooled units? •How is this assured in many aircraft installations?
Servicing procedures and precautions.	•Why should both male and female connectors be inspected each time before any unit is plugged in? •If a unit resists being pushed fully in, why is it good practice to pull it out and try again rather than try to force it in? •Why should screw type lock-ins be only finger tight, *not* tightened with pliers or wrench?

Activities	*Check Items*
	Did the student:
	•Make sure all lock-ins were fully finger tight? •Inspect shock mounts for condition?

Inspect electrical units mounted on shelves or racks with plug-in connection for electrical circuity. Check security of mounting and electrical connector engagement, integrity and firmness of shock mounts, and clearance of units from interference.	•Make sure ground straps or springs are intact around shock mounts? •Check if unit could be pushed farther in? •Check individual pins for being straight and undamaged? •Check individual sockets for being clear and having proper spring tension? •Make sure no trash or other debris is interfering with air flow around or through units?

INSPECT, CHECK, AND REPAIR PASSENGER CALL SYSTEM.

(SEGMENT G, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information or manufacturer's service data and questions with multiple choice answers concerning passenger call systems.

- **Performance:**
  The student will select answers to ten questions concerning the inspection, checking, and repair of passenger call systems.

- **Standard:**
  At least seven correct answers will be selected.

Key Points	*Feedback*
Purposes and uses of passenger call systems.	•Describe a typical passenger call system for a commercial airliner. •What is the difference between mechanical and electronic chimes? •How is the cabin attendance informed as to which seat has initiated a call? •What purposes other than passenger calls are such systems used for?
Design and operation of passenger call systems.	•What happens when a passenger operates a call button? •What type of relay is used in most call systems to lock-up a call until reset is pushed? •What type of solid-state electronic devices can be used in lieu of relays? •How is the passenger call system checked for proper operation?

LOCATE REPLACEMENT PROCEDURES AND PARTS NUMBERS FOR ELECTRICAL COMPONENT REPLACEM

(SEGMENT H, LEVEL 2)

Student Performance Goal

- **Given:**
  A service manual and parts catalog for a specific aircraft, a list of five electrical components supplied by the instructor.

- **Performance:**
  The student will locate and list the reference page numbers of the replacement procedures for each of the five listed components. He will also list the part numbers of the replacements for the five components and of any additional mounting hardware, seals or gaskets required for replacement.

- **Standard:**
  At least 80 percent of the listed reference page numbers and part numbers will be correct.

Key Points	*Feedback*
Locating replacement procedures for electrical components.	•Will the replacement procedures for an electrical timer for propeller deicing be found under Electrical System or Propellers?
Locating part numbers.	•Explain the use of an alphanumeric index. •If a component is an assembly, where will a breakdown of replac able parts usually be found? •If a component requires specific seals, spacers, or other hardware for installation, where will this information usually be located?

Activities	*Check Items* Did the student:
Use an aircraft service manual to locate replacement procedures and list page numbers for five electrical components specified by the instructor.	•Use the service manual index to expedite finding desired information? •Read all instructions and note any references to other sections of the manual?
Use the parts catalog to locate and list part numbers for each specified component and for any mounting hardware, seals, gaskets, or other accessories needed for replacement of each component.	•Use index of parts catalog to assist in locating desired parts? •Check quantity needed for each item of hardware listed as needed for replacement?

4. IDENTIFY AND SELECT HYDRAULIC FLUIDS.

(EIT = 2 hrs., T = 1 hr., L/S = 1 hr.) 1 segment
(UNIT LEVEL 3)

IDENTIFY AND SELECT HYDRAULIC FLUIDS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
Samples of ester-base, petroleum-base and vegetable-base hydraulic fluids; sample placards of the type used or attached to hydraulic reservoirs; written reference information describing the characteristics and identifying features of hydraulic fluids.

- **Performance:**
The student will distinguish between the sample fluids by color, odor and specification number. When shown the sample placard or reservoir data plate, he will select the fluid that would be used to service the system. He will describe the characteristics of each type of hydraulic fluid.

- **Standard:**
The three types of fluids will be identified without error. Reference information and placards will be correctly identified. Correct nomenclature will be used when describing the characteristics of the fluids.

Key Points	*Feedback*
Vegetable-base fluids: a. Odor.	• What base materials contained in a vegetable-base hydraulic fluid permits identification by odor?
b. Viscosity.	• How would evaporation of alcohol from a vegetable-base fluid affect the viscosity of the fluid? • Why does an external leak of vegetable-base hydraulic fluid leave a gummy deposit? • If a vegetable-base fluid is stored or remains in a vented container for a long period of time, how is the viscosity of the fluid affected? • How do the lubricating characteristics of vegetable- and mineral-base hydraulic fluids compare?
c. Color.	• If a vegetable-base hydraulic fluid removed from a brake system had no color, how could a mechanic identify the fluid? • Is a vegetable-base fluid classified as flammable or non-flammable? • What precautions should be observed if the owner suggests use of automotive hydraulic fluids in the brake system of the airplane?
Mineral-base fluids: a. Odor.	• How does temperature affect the viscosity of mineral-(petroleum) base hydraulic fluid?
b. Viscosity.	• If hydraulic fluids are too viscous, how is the operation of the system affected? • If hydraulic fluids become too hot, what is the effect on minor internal (and external) leaks in the system? • Why are the containers in which hydraulic fluids are supplied often marked "Destroy this can. Do not re-use"?
c. Color.	• If the fluid removed from a hydraulic system had lost its color, how could the mechanic identify the fluid as a mineral-base fluid? • What is the color of petroleum-base hydraulic fluid?
Chemical base fluids: a. Trade names.	• Why are chemical base fluids often described as non-flammable hydraulic fluids?
b. Odor.	• Describe some of the characteristics of the synthetic/chemical fluids which offset the desirable characteristics of non-flammability.
c. Applications and precautions.	• What are some of the hazards and precautions which should be observed by mechanics who use Skydrol and similar type fluids?

- Describe the limits to the service life of some of the chemical base fluids.
- What materials are used to flush the systems and clean components that are to be used with non-flammable fluids?
- What contamination problems exist in the use of synthetic fluids?

Activities	*Check Items*
	Did the student:
Identify samples of vegetable, petroleum and synthetic base hydraulic fluids. Describe the characteristics of each type of fluid.	• Use and correctly interpret reference information as a guide to the selection of the type of fluid? • Use correct nomenclature and terminology as a part of the explanation and description?

5. REPAIR HYDRAULIC AND PNEUMATIC POWER SYSTEM COMPONENTS. (EIT = 15 hrs., T = 7 hrs., L/S = 8 hrs.) 4 segments

(UNIT LEVEL 2)

SELECT AND INSTALL SEALS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
Hydraulic components not requiring complex assembly, disassembly, (i.e., master and wheel brake cylinders, actuating cylinders, etc.) various types and sizes of seals and fluids, reference information describing the procedure for replacing and testing seals in a hydraulic unit and a means for testing the following seal replacement.

- **Performance:**
The student will use and interpret information that will assist in identifying and selecting seals for use in ester, petroleum and vegetable-base hydraulic fluids. He will install seals in one unit in accordance with the procedures specified in the manual and test the unit following reassembly.

- **Standard:**
The unit which has had the seals replaced will function as it was designed to operate and will be free of both external and internal leaks.

Key Points	*Feedback*
Types of seals: a. Materials.	• What material is used to manufacture seals for use in vegetable-base hydraulic fluids?
b. Shape.	• What material is used for seals designed for use in a petroleum-base fluid? • What material is used for seals to be used in the synthetic fluids? • What is the shape of a seal that is described as a chevron type seal? • What is the cross-sectional shape of an "O" ring? • What is the basic difference between a gasket and a seal?
Identification of seals.	• What is the significance of the colored identification which appears on many hydraulic seals? • How may a mechanic identify the material from which a seal was manufactured? • Why are seals often individually packaged in a weather resistant type envelope or container?
Installation of seals.	• Where would a mechanic find information specifying the part number and describing the location of a seal within a component? • What installation procedure will minimize the possibility of damage to a seal as it is moved past the external threads on a part of the component? • What installation procedure will minimize the possibility of damage to a seal as it is moved past the internal threads in a part? • What lubricant may be applied to a seal prior to installation in the component? • What is the function of a back-up ring that may be used on either side of the "O" ring? • When chevron seals are installed to provide a pressure seal, what is the position of the chevron with respect to the applied pressure?

Activities	*Check Items*
	Did the student:
Identify the correct seal for installation into one hydraulic unit or component.	• Use and correctly interpret information from the reference manuals?

Install a seal in a component not requiring complex assembly.	• Follow the procedure specified in the manual? • Avoid damaging the seal and component?
Test the component following installation of the seal.	• Achieve an installation which assured normal operation without external and internal leakage?

IDENTIFY, REMOVE AND INSTALL A HYDRAULIC SELECTOR VALVE.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  An operational hydraulic system or a segment including at least a source of hydraulic pressure, a selector valve and actuating cylinder, written service instructions, a spare selector valve for installation into the system, line cap-plugs and a supply of hydraulic fluid.

- **Performance:**
  The student will identify, remove and install a selector valve into the system. He will operationally check the system following replacement of the selector valve.

- **Standard:**
  The selector valve will be identified regardless of the type of valve. The removal and installation procedure will be adhered to without error or omission. The system will function as it was designed to operate.

Key Points	*Feedback*
Types of selector valves.	• Where is a selector valve located with respect to the pressure source and the actuators in the hydraulic system? • Describe three different types of selector valves. • How many ports are required in a selector valve?
Installation of selector valves.	• Why must hydraulic system pressure be relieved before disconnecting any component in the system? • What procedure will reduce the possibility of contamination to a minimum when lines are disconnected? • Where would a mechanic find information that specifies the procedure for installation or removal of hydraulic components?

Activities	*Check Items* Did the student:
Identify and remove a selector valve from a hydraulic system. Install a selector valve and check system operation.	• Use and correctly interpret instructions from the reference publications? • Use correct procedures and observe safety precautions? • Achieve a system that functioned normally?

REMOVE AND INSTALL PRESSURE REGULATORS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  An operational hydraulic system, written reference information, a replacement pressure regulator, line cap-plugs and a supply of hydraulic fluid.

- **Performance:**
  The student will identify, remove and install a pressure regulator in the hydraulic system. He will test the system following installation of the regulator and adjust the pressure of the system.

- **Standard:**
  The procedures will be fully in accordance with the written instructions. The pressure will be adjusted within the tolerance specified in the instructions.

Key Points	*Feedback*
Pressure regulators.	• What is the purpose of a pressure regulator in the system? • What reference information is available to a mechanic that would describe the procedure for installing, removing or adjusting a pressure regulator? • If a system operational fault is isolated and definately proven to be the fault of the regulator, is the regulator overhauled in the field or removed and replaced with a servicable component?

Activities	*Check Items* Did the student:
Identify and remove a regulator from the system.	•Correctly interpret information from the manual? •Follow the recommended procedures?
Install, check and adjust a pressure regulator.	•Observe safety precautions? •Achieve an adjusted system pressure that met the specified tolerance?

INTERPRET AND DESCRIBE THE OPERATION OF A PNEUMATIC POWER SYSTEM.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Diagrams and drawings of a pneumatic power system including at least a multi-stage compressor, filter, intercooler, filter and/or oil separator; written reference information describing the operation of the system.

- **Performance:**
  The student will interpret information and explain the principles of pneumatics and the operation of the specific system.

- **Standard:**
  Explanations and descriptions will be in accordance with the technical information provided. Correct nomenclature and terminology will be a part of all explanations and descriptions.

Key Points	*Feedback*
Pneumatic systems.	•Why is air used as a power source in some systems of the aircraft? •Why are multi-stage compressors often used as a power source for the pneumatic system? •What is a Roots-type compressor? •When pneumatic air is used as a power source, why is it often necessary to cool the air? •How are the compressors lubricated? How is oil separated from the compressed air? •What causes the accumulation of moisture or water vapor in a pneumatic system? •What devices are used to store high pressure air?

Activities	*Check Items* Did the student:
Describe the operation of a specific pneumatic system.	•Use and correctly interpret reference information? •Use correct nomenclature and terminology as a part of the explanation and description?

6. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR HYDRAULIC AND PNEUMATIC POWER SYSTEMS. (EIT = 55 hrs., T = 25 hrs., L/S = 30 hrs.) 10 segments

(UNIT LEVEL 3)

SOLVE PROBLEMS INVOLVING FORCE, AREA AND PRESSURE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Ten problems (sketches, drawings or narrative), illustrating the relationship of applied force, area of cylinder or piston, and pressure per unit area.

- **Performance:**
  The student will solve the problems when one of the factors is unknown or the values have been changed. He will explain the hydraulic principles involved in the solution of the problem.

- **Standard:**
  Eight of the ten problems will be correctly solved. Correct nomenclature and terminology will be used throughout the explanations.

Key Points	*Feedback*
Simple levers: a. Force.	•How is a simple lever used to produce an increase in force? •Describe some examples of the use of simple levers in the systems of an airplane.
b. Lever arms.	•How may a simple lever be used to decrease an applied force? •What are the limitations to the multiplication of force through the use of levers?
c. Efficiency.	•How efficient is a simple lever?

d. Mechanical advantage.	**•What is meant by the term "mechanical advantage"?** **•What is reduced or sacrificed to achieve mechanical advantage in a simple lever system?** **•Show by sketch the lengths of the lever from fulcrum to force, that are required to produce a mechanical advantage of four.**
e. Speed (rate of travel).	**•What must be reduced or sacrificed to achieve an increase in speed in a simple lever system?** **•What is the relationship between mechanical advantage and speed in a lever system?** **•How may a simple lever be used as a speed reducer?**
Hydraulic/pneumatic advantage:	**•How is a mechanical advantage achieved in a hydraulic system?**
a. Comparison of lever systems to hydraulic/pneumatic systems.	**•What similarities or relationships exist between simple levers and hydraulic "levers"?** **•What is the relationship between hydraulic advantage and speed?**
b. Relationship of force, pressure and area.	**•What results when the force acting against a piston area is increased?** **•How does hydraulic pressure react within a hydraulic system?** **•How is hydraulic pressure related to piston force output?**
c. Units of measurement, (force, pressure, area).	**•In what units of measurement would the force applied to a control wheel be expressed?** **•In what unit would a mechanic express the pressure of a hydraulic system?** **•With respect to hydraulics, in what units are the areas of hydraulic pistons measured?** **•In what units of measurement would the length or travel of a piston in an actuating cylinder be measured?**
Incompressibility of fluids.	**•How does the shape, size or volume of a container effect hydraulic pressure?**
Transmission of force:	**•Explain the hydraulic principle that permits the transfer of force in an hydraulic system.**
a. Conversion of force to pressure.	**•What are some of the methods for increasing a given force?**
b. Conversion of pressure to force.	**•What force would be exerted by a 4 square inch piston when a pressure of 100 PSI is applied?**
c. Efficiency of a system.	**•What minimum hydraulic pressure would be required to overcome 800 pounds of force acting against a flap if the piston in the hydraulic cylinder had an area of 4 square inches?**
d. Speed (rate of travel).	**•What governs the speed of an actuating cylinder?** **•Compare the force and speed relationship between identical actuating cylinders connected to the same pressure source.** **•Compare the force and speed of two actuating cylinders that have the same piston areas but different strokes that are connected to the same pressure source.** **•Compare the speed and force relationship of two actuating cylinders of different diameters that are connected to the same pressure source.** **•Explain why an actuating cylinder with a piston rod at only one end will probably have different rates of travel when moving in opposite directions.** **•What type of actuating cylinder will generally have equal rates of travel in both directions?**
f. Displacement.	**•How is the displacement of an actuating cylinder expressed?**

	•How does the piston rod of an actuating cylinder effect the piston displacement when the piston is moving in the reverse direction? •What unit of measurement is used to express the output of a pump?

Activities	*Check Items*
	Did the student:
Solve ten problems involving force, area and pressure. Explain the hydraulic principles reflected by the problems.	•Correctly interpret the terms necessary to solve the problems? •Correctly solve eight of the ten problems? •Use correct nomenclature and terminology?

INTERPRET REFERENCE INFORMATION PERTAINING TO OPERATION OF A BASIC HYDRAULIC SYSTEM.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Reference manuals, drawings, diagrams, mock-ups, or components installed in an aircraft hydraulic system, including but not limited to: reservoir pumps, actuating cylinders, check valves, selector valves, relief valves, regulators, accumulators, fuse, flap overload valve, sequence valve, crossflow valve, shuttle valve and pressure gauges.

- **Performance:**
  The student will interpret the reference information and diagram a basic hydraulic system. He will show and explain the relationship, purpose and function of each component in the system.

- **Standard:**
  Reference information will be interpreted without error. Correct nomenclature and terminology will be a part of all explanations and descriptions.

Key Points	*Feedback*
Hand pumps.	•What is the purpose of a hand pump in the hydraulic system? •What pressures can be achieved by the use of a hand pump? •Where is a hand pump generally installed in an aircraft? •How is mechanical force converted into hydraulic pressure in a hand pump?
Actuating cylinders.	•Describe the speed and movement of an actuating cylinder that was being actuated by a hand pump. •How many fluid lines are connected to an actuating cylinder? How may the "up and down" lines be identified? •Explain how hydraulic pressure is converted to a force by an actuating cylinder.
Reservoir.	•Explain why the fluid level in a reservoir varies when hydraulic components are being operated. •What is the primary purpose of a reservoir? •Where is a reservoir installed with reference to the location of the hydraulic pump? •How is hydraulic fluid quantity indicated in a reservoir?
Check valves.	•What is the purpose of a check valve? •What does an arrow designate on a check valve? •What would most likely occur if a check valve is not installed between a hand pump and a reservoir? •Where are check valves usually placed in an hydraulic system?
Selector valves.	•What is the purpose of a selector valve? •Where is a selector valve located in an airplane? •What hydraulic pressures are routed through a selector valve?
Relief valves.	•What is the primary purpose of a system relief valve? •Where is the relief valve located in the hydraulic system? •What would result if a relief valve stuck in an open position? In a closed position? •What protection is provided to the hydraulic system by the action of the system relief valve?

Power pumps.	•What is the advantage of a power pump over a hand pump in the hydraulic system? •What means are employed to drive a power pump? •Where is a power pump installed in a hydraulic system? •Where is a power pump located with respect to the hand pump?
Pressure regulator.	•What is the purpose of the pressure regulator? •What other hydraulic component serves as a "back-up" to the pressure regulator? •What other name is frequently used to describe a pressure regulator? •When a pressure regulator "kicks-out," how is the hydraulic power pump "unloaded"?
Accumulator.	•What is the purpose of an accumulator? •What maintains hydraulic pressure in an accumulator when the hydraulic pump is not operating? •Where is an accumulator installed in a hydraulic system? •Why is it necessary that a mechanic have access to an accumulator? •If an accumulator has an air pre-load of 600 PSI, what is the air pressure in the accumulator when the hydraulic system pressure has reached 1800 PSI? •Describe how an accumulator serves to supplement pump flow and dampen pressure surges in the hydraulic system.
Orifice check, flap overload, sequence, crossflow and shuttle valves.	•What is the intended purpose for each of the valves? •Are flap overload valves installed in the flap up or the down lines? •Explain how a sequence valve may be mechanically actuated.
Hydraulic fuses.	•How does a fuse operate? •What is the purpose of a fuse? •Indicate the possible locations for a fuse.
Pressure gauges and snubbers.	•What kind of mechanism is enclosed within the case of a hydraulic pressure gauge? •Why does hydraulic pressure in the system tend to fluctuate? •What device is often installed to protect the pressure gauge mechanism and prevent fluctuations in the pressure indications?

Activities	*Check Items*
	Did the student:
Interpret the reference information and diagram a basic hydraulic system.	•Correctly interpret the information? •Illustrate all components in their correct relationship to each other?
Explain the purpose and function of each unit in the system.	•Use correct nomenclature and terminology as a part of the explanation and description?

COMPARE CONSTANT PRESSURE AND OPEN CENTER TYPES OF HYDRAULIC SYSTEMS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  Charts, manuals, mock-ups or complete aircraft hydraulic systems of the constant pressure and the open center types.

- Performance:
  The student will identify each type of system and compare the components and the means of system pressure regulation.

- Standard:
  The reference information will be interpreted and the comparison made without error. All explanations and descriptions of operation will include use of correct nomenclature and terminology.

Key Points	*Feedback*
Constant pressure systems.	•What features identify a constant pressure hydraulic system? •What components are considered essential to a constant pressure system?

	•Why are pressure actuated electrically driven auxiliary pumps often included in a constant pressure system?
Open center systems.	•What characteristic identifies an open center hydraulic system? •What pressure exists in an open center system when the pumps are operating and the selector valve is in neutral position? •What pressures exist in an open center system when the pumps are operating and several hydraulic components are operating? •When the actuator of an open center system reaches the end of its travel, what will occur with regard to system pressure? •What causes an open center selector valve to return to a neutral position? •Why is an accumulator unnecessary to the operation of an open center system?

Activities	*Check Items* Did the student:
Identify and describe the operation of: a. Constant pressure systems. b. Open center systems.	•Correctly interpret information, describing the operation of the components of the system? •Use correct nomenclature throughout the explanation?

INSPECT AND SERVICE HYDRAULIC RESERVOIRS.
(SEGMENT D, LEVEL 3)

Student Performance Goal

• Given:
An operational hydraulic system or mock-up provided with a vented or a pressurized reservoir; a supply of hydraulic fluids and written inspection and service instructions applicable to the specific system.

• Performance:
The student will inspect and service the reservoir with fluid and check the filter for contamination.

• Standard:
The inspection and servicing procedure will be fully in accordance with the servicing instructions.

Key Points	*Feedback*
Hydraulic reservoirs: a. Filler openings.	•Why are vented reservoirs located in the airplane at a position that is higher than the pumps? •Why are some reservoirs pressurized? •What precautions should be observed when removing the filler cap from pressurized reservoirs?
b. Expansion space.	•Why must an expansion space be maintained in a reservoir? •If the return flow of hydraulic fluid to the reservoir is carrying entrapped air, how is the air separated from the fluid?
c. Fluid quantity.	•What information would be included on the placard at the reservoir filler opening? •Explain why a dip-stick quantity guage may have more than one indicator or mark to indicate the level of the fluid in the reservoir. •Why may the system pressure have to be released when checking the fluid level in the reservoir of some hydraulic systems?
d. Filters.	•If a reservoir is provided with an integral filter, where would a mechanic find information specifying the inspection periods, cleaning? •If it is not possible to pour fluid directly into a reservoir, how may fluid be added without contaminating the hydraulic system? •Why are paper type filter elements normally discarded and replaced with new elements rather than being cleaned? •What information should be used to determine the "service inspection" period for replacement or cleaning of a filter element?

	•What would most probably cause an external fluid leak following replacement of a filter element?

Activities	*Check Items*
	Did the student:
Verify fluid level in reservoir and add fluid as required. Check the filter for contamination.	•Correctly interpret instructions contained in the airplane manual? •Follow the recommended procedures?

IDENTIFY AND DESCRIBE THE OPERATION OF CONSTANT AND VARIABLE DISPLACEMENT HYDRAULIC PUMPS.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- **Given:**
  Visual aids, manuals and a sample or cutaway of a constant and variable displacement type hydraulic power pump.

- **Performance:**
  The student will identify and describe the operation of one pump of each type.

- **Standard:**
  Reference information will be correctly interpreted. Correct nomenclature will be used when identifying and describing pump operation.

Key Points	*Feedback*
Constant displacement pumps.	•How may a mechanic determine the direction of a power pump? •How may a mechanic identify the inlet and outlet ports of power pumps? •How may a mechanic differentiate between a constant displacement and a variable displacement type pump?
Variable displacement pumps.	•How are hydraulic pumps lubricated? •What happens if the gears or pistons of a pump seize or "freeze" during operation?

	•As variable displacement (volume) hydraulic pumps automatically regulate pressure within a system, why may the system incorporate a system relief valve but may not include a system pressure regulator or pump unloading valve?

Activities	*Check Items*
	Did the student:
Describe the operation of: a. Constant displacement type hydraulic pumps. b. Variable displacement pumps.	•Correctly interpret information from the reference manuals? •Use correct nomenclature and terminology as a part of the explanation and description.
Identify each type of pump.	•Correctly identify each pump?

CHECK, INSPECT, REMOVE AND INSTALL HYDRAULIC POWER PUMPS.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational hydraulic system installed in an aircraft or on a mock-up; three engine driven hydraulic pumps, at least one of which has a worn or sheared drive shaft; a suitable accessory drive drive pad and written instructions describing the inspection, installation and removal of the hydraulic pump.

- **Performance:**
  The student will inspect the pump drive shafts and identify the pump with the defective shaft. He will remove and install a pump on the accessory drive pad and check operation of the system following pump installation.

- **Standard:**
  The pump with the defective shaft will be identified without error. Reference information will be correctly interpreted. Removal, installation and checking will be in accordance with the written procedures.

Key Points	*Feedback*
Methods of driving pumps: **a. Engine driven.** **b. Electrically driven.**	**•What feature of the drive spline prevents damage to the accessory section of an engine if the hydraulic pump seizes?** **•What kinds of seals are usually incorporated into the driving shaft to prevent leakage of fluids and engine lubricating oil?**
Inspection of pumps.	**•When a mechanic is preparing to install a replacement pump, why and how should he check for freedom of rotation?** **•Why may the manual specify lubrication of the pump drive splines before installation?** **•If a hydraulic pump is discharging fluid from the pump drain line, what seal has probably failed?** **•If a hydraulic pump is discharging engine oil from the case overboard drain, what is the most probable fault?**
Removal and installation of hydraulic pumps.	**•How could a mechanic determine whether a pump should be installed with or without a gasket between the pump pad and the accessory case pad of the engine?** **•Why is it important that the mechanic correctly torque the nuts on the studs at the pump mounting pad?** **•Why are the pressure and supply lines to the pumps generally provided with quick line-disconnects?**

Activities	*Check Items*
	Did the student:
Inspect pump drives and identify the pump with the defective shaft.	**•Select the defective pump?** **•Correctly interpret information from the instructions?**
Remove, install and check operation of a pump.	**•Follow the specified procedures?** **•Accomplish the removal, installation and check at a return-to-flight standard?**

TROUBLESHOOT HYDRAULIC PUMPS.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational hydraulic system that may be supplied with pressure from an auxiliary power source and written service information.
- **Performance:**
  The student will troubleshoot the hydraulic system after the instructor has introduced air into the pump. The student will prime the pump and purge air from the system.
- **Standard:**
  The procedures will be in accordance with the reference information. The pump and system will operate as specified following correction of the fault.

Key Points	*Feedback*
Troubleshooting hydraulic pumps.	**•How would a mechanic identify a power pump which was operating with an "air lock"?** **•What may cause a pump to "chatter"?** **•What will be the effect of an air leak in the intake supply line to a hydraulic pump?** **•What reference information is available to a mechanic for assistance in troubleshooting problems in the hydraulic power system?** **•What procedure is generally effective in priming a pump?**

Activities	*Check Items*
	Did the student:
Describe the symptoms associated with a pump that is air locked.	**•Correctly interpret information from the reference manuals?** **•Use correct nomenclature and terminology as a part of the explanation and description?**
Prime the hydraulic pump and check system operation.	**•Follow the procedures specified in the manual?** **•Achieve an operational hydraulic power system?**

REMOVE, INSTALL, INSPECT, SERVICE AND CHECK A HYDRAULIC ACCUMULATOR.

(SEGMENT H, LEVEL 3)

Student Performance Goal

- Given:
  An operational constant pressure hydraulic system including one or more pressure accumulators, suitable line sealing caps, a supply of hydraulic fluid and appropriate written service instructions.

- Performance:
  The student will remove, inspect and install an accumulator in the system. He will charge the accumulator with air or nitrogen and check the operation of the system. He will replace high pressure air valve assemblies as necessary.

- Standard:
  All tasks will be accomplished in accordance with the manufacturer's maintenance instructions. The system will, following servicing, comply with all operational specifications established in the written service instructions.

Key Points	*Feedback*
Operation of accumulators.	● Why is it necessary that an accumulator have an air charge in order to maintain pressure in the hydraulic system? ● What design feature ensures that the air in the accumulator is not forced into the hydraulic system during normal operation? ● What device makes possible the admittance of air or nitrogen to the accumulator?
Servicing of accumulators.	● Why is nitrogen preferred to air as a charging medium for the accumulators? ● How would a mechanic distinguish between a high pressure valve assembly that has a core and a valve assembly that has a poppet valve? ● How would a mechanic identify a "high pressure" type valve core? Why shouldn't common valve cores be used as a replacement parts for accumulators? ● What hazard is involved when handling, installing or disassembling pressure accumulators? ● With reference to the fluid and air fittings, in what position is an accumulator mounted in the airplane? ● What reference publication will contain instructions and information relative to the preload charge of an accumulator?
Inspection, removal and installation of accumulators.	● How are fluid leaks in an accumulator detected? How are air leaks detected? ● How can the "pre-charge" of an accumulator be determined by using the system hydraulic pressure gauge? ● What inspection procedure could be followed to confirm a suspected leak at the diaphragm of a spherical accumulator? ● What inspection procedure would assist in detecting an air leak at the air valve assembly? ● What procedure should be followed to release air from the accumulator? ● How would a mechanic dissipate system pressure before disconnecting any lines in the hydraulic system?

Activities	*Check Items*
	Did the student:
Remove and install an accumulator in the system.	● Use and correctly interpret instructions from the reference information? ● Follow the prescribed procedures?
Charge the accumulator and check system operation.	● Accomplish the task within specified tolerances? ● Observe safety precautions?

TROUBLESHOOT AND DETERMINE THE CAUSE OF LOW, HIGH OR FLUCTUATING SYSTEM HYDRAULIC PRESSURE.

(SEGMENT I, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational hydraulic system including at least a power supply pump, pressure regulating devices, accumulators, flow control valves, actuators and the manufacturer's publications applicable to the specific system.

- **Performance:**
  The student will operate the system, compare the operating characteristics with the reference information, and detect low, high or fluctuating pressures when faults are introduced into the system by the instructor. He will interpret information from the service publications and describe the probable cause for the observed malfunction. He will make necessary adjustments to restore the system to operating tolerances.

- **Standard:**
  Operation, adjustments and analysis of faults will be in accordance with the written reference information. Following observance and analysis of faults, the system will be restored to operating tolerances specified in the instructions.

Key Points	*Feedback*
Normal system operation.	• Where would a mechanic find information that describes the normal pressures, times and specifications applicable to a system? • What components are associated with system pressure regulation? • What is the importance of fluid level in the supply reservoir when considering "normal" system operation? • Explain why operating temperatures should be considered when evaluating what is a "normal" operating condition.
Low system pressures.	• Explain how a faulty pressure regulator could be the cause of low system pressures.
High system pressures.	• Describe how a leaking system relief valve could affect system pressures. • Explain why a pressure regulator is often called a pump "unloading" valve. • When a pressure regulator is in the "charging" or "cut-in" position, what happens to the fluid that is being delivered to the system by the pump?
Fluctuating pressures.	• When a pressure regulator is operating in the "unloaded position," what happens to the fluid that is being delivered to the system by the pump? • If the pressure regulator fails to "unload" the pumps, what is the effect on the system? • Why is an accumulator generally necessary to the proper operation of a pressure regulator?
Adjustment of pressures.	• If the air (pre-load) charge in the accumulator is low, why will the pressure regulator cycle more frequently than normal? • If the air (pre-load) charge in the accumulator is too high, how will the operation of the pressure regulator be effected? • Why do some electrically-driven pump systems not require a pressure regulator? • Why are the pressure regulators and accumulators usually located close to each other in the pressure manifold of the hydraulic system? • If the pressure adjustment of the regulator is accomplished by "shimming" behind the control spring, where would a mechanic find the limits applicable to this "field adjustment"? • If the system incorporates multiple relief valves that are adjusted to different pressures, what is the sequence for adjusting the valves in the system?

Activities	*Check Items* Did the student:
Operationally check the system.	•Use and correctly interpret reference information in order to determine "normal" operating conditions?
Detect faults and describe probable cause.	•Use correct nomenclature and terminology as a part of the description and explanations?
Adjust pressure to specified tolerances.	•Achieve the specified tolerances in the operation of the components and system?

INSPECT, CHECK AND SERVICE A HYDRAULICALLY OPERATED FLAP SYSTEM.

(SEGMENT J, LEVEL 3)

Student Performance Goal

- **Given:** An operational hydraulic flap system installed in the aircraft or on a mock-up, and the manufacturer's maintenance and service publications or written reference information.
- **Performance:** The student will inspect, check and service the flap system.
- **Standard:** The tasks will be accomplished in accordance with the written instructions and will result in a system that operates within the tolerances specified in the instructions.

Key Points	*Feedback*
System operation.	•What publication should a mechanic use to determine the tolerances applicable to a specific flap system? •What is the source of pressure and fluid flow required to power the flap system of an airplane? •What component within the system prevents flap extension at airspeeds above the design speeds for the system?
Inspection of flap systems.	•What publication will contain information specifying the flap travel adjustments of limits? •What amount of leakage is acceptable in a flap actuator? •Describe why a flap position indicator is a requirement for all airplanes incorporating flap systems.
Adjustment of flaps.	•What is meant by the term "assymetrical" flap positions? •What system fault may result in "drooping" flaps? •What adjustment is generally necessary to adjust the "full-up" position of the wing flaps?

Activities	*Check Items* Did the student:
Operate, inspect and service a hydraulic flap system.	•Use and correctly interpret manufacturer's manuals and specifications? •Adhere to operating and inspection procedures? •Observe safety precautions during operation of the system?

AIRCRAFT LANDING GEAR SYSTEMS

7. INSPECT, CHECK, SERVICE AND REPAIR LANDING GEAR, RETRACTION SYSTEMS, SHOCK STRUTS, BRAKES, WHEELS, TIRES, AND STEERING SYSTEMS. (EIT = 82 hrs., T = 32 hrs., L/S = 50 hrs.) 15 segments

UNIT LEVEL 3)

CLEAN AND STORE TIRES.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Used aircraft tires, approved tire cleaning materials and appropriate written information describing the cleaning and storing of tires.

- **Performance:**
  The student will clean an aircraft tire, removing oils and other deteriorating materials and describe the procedure to be followed when storing tires and other rubber aircraft products.

- **Standard:**
  The cleaning and description of procedure will comply with the reference information without error or omission.

Key Points	*Feedback*
Tire cleaning.	•What cleaning materials should be used to clean tires? •What precautions should be taken to prevent damage caused by hydraulic fluids and other kinds of oil and grease? •What is the effect of ester-base chemicals on aircraft tires?
Tire storage.	•How are aircraft tires prepared for storage? •In what position should tires be stored? •When selecting a location for tire storage, what are the requirements regarding sunlight, temperature. relative humidity and other atmospheric conditions? i.e., ozone, etc.

Activities	*Check Items* Did the student:
Clean one tire, removing all oil, grease or other chemicals.	•Select and correctly use the proper cleaning agents? •Completely remove all oil or chemicals from the tire?
Describe the procedure for storing tires and rubber products	•Use correct nomenclature and correctly describe storage practices?

INSPECT, DEMOUNT, DETERMINE REPAIRS NEEDED AND REINSTALL TIRES ON WHEELS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  Aircraft wheels with tires of both the tube and tubeless types, written procedures for tire servicing, AC 43.13–1 or equivalent publications and appropriate tire servicing tools and equipment.

- **Performance:**
  The student will demount one tubeless tire and one tube type tire from the wheel. He will inspect the tires, tube and wheel assembly, determine the necessary repairs, make one repair to a tube, reinstall the tire and tube and inflate to correct pressures. He will practice and explain the safety precautions related to tire servicing.

- **Standard:**
  Written procedures will be followed without error. One completed tire installation will conform to return-to-service standards.

Key Points	*Feedback*
Demounting procedure.	•Why must a tire be fully deflated prior to demounting? •What precautions should be taken to protect a tube while demounting the tire casing? •Why should a known puncture location be marked before the tire is removed from the wheel?
Inspection of tires and tubes.	•Why must the tire, tube and wheels assembly be inspected? •What faults are normally found when checking a valve core in a tube type tire?

	• What damage is common to the flanges and bearings of wheels?
Tire and tube repairs.	• How would a mechanic become aware of the limits applicable to cuts and bruises in a tire casing? • What is the effect of an "out of round" tire? • What is meant by "growth" in a tire? Why is the installation of a recap tire on a retractable landing gear often critical with regard to tire and wheel diameter? • If a tube requires a patch, why should the tire casing also be inspected? • Where would information classifying the tire repairs as repairable and nonrepairable be found? • Describe how a spot repair to a damaged tire casing would be accomplished. • Describe some of the procedures that may be used to balance an out-of-balance tire.
Installation of tires and tubes.	• Why should tire-talc, soapstone powder, etc., be applied to a tube before it is installed into the tire casing? • What precautions should be observed when installing a tire onto the wheel? • What balance marks are commonly used on tire casings and tubes?
Inflation of tires.	• What are slippage marks and how are they applied to a tire and wheel assembly? • Why should a tire be inflated, deflated and reinflated when making the initial installation of a tire and tube assembly? • Why should the inflation pressure of the tire be related to the gross weight of the airplane? • What is a safety cage, and if a safety cage is available, when and how should it be used?

Activities	*Check Items*
	Did the student:
Demount a tubeless tire and a tube type tire from the wheel.	• Inspect both tire and wheel for damage and wear before removing the tires? • Mark known or suspicious puncture or damaged areas? • Fully deflate the tube or tire before demounting?
Inspect tire, tube and wheel.	• Inspect inside of tire casing as well as the tube? • Correctly interpret the information from AC 43.13–1 regarding repair of tire, tubes and wheels?
Patch a tube and describe repair of a tire casing.	• Adhere to the written procedures? • Check the repaired tube for leaks?
Install tires and tubes on wheel assembly.	• Follow correct mounting procedures? • Correctly maintain balance and align marks? • Inflate to correct pressures?
Practice safety.	• Observe and demonstrate regard for safety during all stages of tire servicing? • Protect tires and tubes from damage?

REMOVE, INSPECT, SERVICE AND REINSTALL A WHEEL ASSEMBLY ON THE AXLE.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
  An aircraft wheel assembly mounted on an airplane or on a mock-up, appropriate written service information and wheel removal tools and equipment.

- **Performance:**
  The student will raise the aircraft and remove the wheel from the axle. He will inspect the wheel assembly and bearings and prepare a written list of five discrepancies that are commonly found. He will describe the reasons for rejecting wheel components and describe the repairs that may be accomplished. He will lubricate the bearings of the wheel assembly, reinstall the wheel on the axle, adjust the bearing play, and lower the airplane.

● **Standard:**

Service information and procedure will be followed without error or omission. Correct nomenclature will be used as a part of the descriptions and explanations. The task will be accomplished at a return-to-service standard.

Key Points	*Feedback*
Sources of service information.	**●Where would a mechanic locate information that details the servicing of wheels?** **●What reference information would specify the inspection of bearings, wheels, etc.?**
Jacking procedures.	**●Where would a mechanic find information detailing the techniques to be followed to raise the wheel off the ground?** **●What safety precautions should be observed when jacking an airplane to remove a wheel?**
Axle thread protection.	**●Why should the axle threads be protected?** **●What methods may be used to protect the threads on the axle?**
Wheel bearings.	**●What type of bearing is generally used as a bearing for a landing gear wheel?** **●What bearing faults are most common to landing gear wheel bearings?** **●What procedure should be followed to clean a tapered roller bearing?** **●What procedure should be followed to pack a wheel bearing with grease?** **●What protection should be provided to a bearing before it is reinstalled into the wheel?** **●How could a mechanic determine the type of grease to be used when repacking a bearing?**
Inspection of wheels.	**●How does a removable flange wheel differ from a split wheel?** **●How may elongated bolt holes in a wheel be repaired?** **●Name and describe some of the causes for rejection of a wheel. What are some of the repairs which may be made to a wheel?** **●If the wheel is made of cast magnesium, why must hammering and prying on the wheel be avoided?** **●What action should be taken if inspection reveals a dent or crack in a magnesium wheel?** **●What operating conditions may lead to burned, pitted or worn bearings in the wheel?** **●What portions of the wheel assembly are most likely to corrode?**
Installation of wheels.	**●Why is it important that installation procedures be followed when installing wheels?** **●Why is proper torque important when installing the through bolts in a split wheel assembly?** **●What precautions will avoid contamination of the wheel bearings during installation of the wheel?** **●Describe a procedure that will result in correct bearing adjustment.** **●What is the importance of adhering to the correct torque values when adjusting the wheel bearings?** **●Describe two methods of safetying the wheel retaining nut to the axle.**

Activities	*Check Items*
	Did the student:
Jack or lift airplane.	**●Correctly interpret information and follow recommended jacking procedures?** **●Observe and practice safety in all phases of the operation?**
Remove the wheel assembly.	**●Adequately inspect wheel and detect defects?**
Inspect all wheel components.	**●Select correct lubricants and properly pack bearings?**

Pack wheel bearings. Reinstall and safety wheel assembly on axle.	•Correctly torque nut and maintain bearing adjustment? •Correctly safety retaining nut?

DISASSEMBLE, IDENTIFY COMPONENTS AND REASSEMBLE MECHANICAL AND HYDRAULIC TYPE BRAKE ASSEMBLIES.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Typical shoe type mechanically operated aircraft brakes: samples of hydraulically actuated brakes of the servo, expander-tube, single and multiple disc types; drawings or diagrams of each type of brake, written service information that identifies the components and describes the operation of the system.

- **Performance:**
  The student will disassemble, identify the components, describe the operation and reassemble each brake assembly.

- **Standard:**
  Brake assemblies need not meet return-to-service standards. Disassembly, inspection and reassembly operations will be in complete accordance with the service information provided. Correct nomenclature and terminology will be used throughout the descriptions of operation of the systems.

Key Points	*Feedback*
Comparison of systems.	•Compare hydraulically actuated and mechanically actuated aircraft brake systems.
Operating principles.	•What are the basic methods of transmitting applied forces from the brake pedals to the wheel brake mechanism? •What is the difference between a single-servo and a duo-servo brake? •Describe the method of applying pressure to the braking surface in an expansion-tube, single-disc and multiple-disc brake. •Compare the function of a brake drum and a brake disc. •Which types of aircraft brakes use a brake drum? •In a disc type brake, how are the discs anchored to the wheel? •What is the difference between a primary shoe and a secondary shoe in a duo-servo brake?
Brake Servicing	•What methods are provided to permit adjustment of brake clearance on shoe type brakes? •How are the block segments anchored to the brake frame in an expander-tube type brake? •Why are all of the block segments of an expander-tube type brake replaced rather than replace a single-block segment? •Why isn't a mechanical adjustment provided on an expander-tube brake? •How is pressure applied to a multiple-disc type brake? •What feature in the design of a multiple-disc brake serves to avoid dragging brakes? •In a "spot" type single-disc brake, how is pressure applied to the rotating disc? •In a floating "caliper" type single-disc brake, how is the lining material attached to the brake housing?

Activities	*Check Items*
	Did the student:
Disassemble, identify the components and describe operation and reassemble the following brakes: a. Mechanical shoe type. b. Hydraulic shoe type. c. Expander-tube type. d. Multiple-disc type. e. Single-disc type.	•Follow the procedures specified in the service information? •Correctly interpret information pertaining to operation of the system? •Use correct nomenclature as a part of the description of operation?

REPLACE A BRAKE ACTUATING CYLINDER.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational hydraulic brake system installed in an airplane or mock-up, a spare operational actuating cylinder to replace a wheel cylinder installed in the system, written service information, appropriate hydraulic fluids and tools.

- **Performance:**
  The student will replace an actuating cylinder in the wheelbrake assembly, perform a functional test of the system following the replacement of the cylinder.

- **Standard:**
  The system will operate normally. There will be no indications of external or internal leakage.

Key Points	*Feedback*
Locating reference information to determine procedures.	**• Why should a mechanic use the service information as a guide to the removal and replacement of components within a brake system?** **• What procedure will assure minimum loss of fluid during the removal and replacement of the brake wheel actuating cylinder?** **• What precautions should be taken to prevent contamination of the system during replacement of the cylinder?**
Operationally checking brake systems.	**• What items should be inspected while the check is being made?** **• How would a brake lining be effected by hydraulic fluids?** **• What procedure should be followed to remove spilled hydraulic fluids from brake linings and tires?**

Activities	*Check Items*
	Did the student:
Remove and replace a brake wheel actuating cylinder. **Purge or bleed the system.** **Operationally check the brake system.**	**• Follow the correct procedures?** **• Avoid contamination of the system?** **• Correctly check the operation of the system?**

ADJUST CLEARANCE ON A SHOE, MULTIPLE-DISC, AND SINGLE-DISC BRAKE.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- **Given:**
  A mock-up or training device that incorporates a wheel and brake assembly of a shoe, multiple-disc and single-disc types, replacement lining blocks, written service information or manuals and appropriate tools.

- **Performance:**
  The student will remove the wheel from the axle, inspect the brake assembly, adjust the clearance of each brake, as necessary, and reinstall the wheel.

- **Standard:**
  The adjusted brake (shoe, multiple and single disc) will comply with the clearance adjustments specified in the service information. The procedures and work accomplished will be of return-to-service standard.

Key Points	*Feedback*
Brake lining.	**• What materials are used as the friction surface materials for brake shoes?** **• How is the brake lining attached to a brake shoe?** **• From what materials are the "spots" or "pucks" of single-disc brakes manufactured?** **• How are spot brake pucks anchored into the brake housing?** **• What effect does a worn puck have on piston alignment of a spot brake?**
Adjustment of brakes.	**• What reference information should be used to determine the correct procedure for adjusting the brakes?** **• Name the tools generally required to check the brake adjustment of each of the types of brakes.** **• What publication would alert a mechanic to the peculiarities and precautions to be observed when adjusting the brakes?**

Activities	*Check Items*
	Did the student:
Remove wheel, inspect brake and adjust clearance on a shoe brake assembly. Remove wheel, inspect brake and adjust clearance on a multiple-disc brake assembly. Inspect and adjust a single-disc type brake assembly.	•Correctly interpret reference information? •Follow specified procedures? •Achieve an adjusted clearance within the tolerance specified in the service instructions? •Maintain return-to-service standards?

INSPECT, REPAIR AND OPERATIONALLY CHECK A MASTER CYLINDER.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- Given:
  An operational brake master cylinder, written service information and overhaul manuals, required seals, gaskets, fluids and suitable equipment to check the operation of a master cylinder.

- Performance:
  The student will disassemble a brake master cylinder, inspect the components, replace seals (as required), reassemble and check the operation of the master cylinder.

- Standard:
  Procedures will be in accordance with the written information. The reassembled cylinder will operate without internal or external leakage.

Key Points	*Feedback*
Brake master cylinders.	•What is the purpose of a master cylinder? •Why do some types of master cylinders provide for a self-contained or integral reservoir? •How would an internal leak in the master cylinder effect brake operation?
Overhaul procedures.	•What publications would probably provide information regarding the replacement of seals in a master cylinder? •What precautions are usually taken to prevent damage to the components and contamination by dirt and dust? •What lubricants are generally used when installing new gaskets and seals in a master cylinder?
Operational testing of reassembled cylinders.	•What check would assist in the detection of an internal leak in a master cylinder? •What symptom would probably indicate a weak or broken return spring in a master cylinder? •What is the purpose of the adjustable linkage on the piston arm of a master cylinder?

Activities	*Check Items*
	Did the student:
Disassemble, inspect, replace seals (as required), reassemble and check a brake master cylinder.	•Follow the correct procedures? •Correctly use tools and avoid damaging the unit? •Achieve the desired operating standard in the reassembled unit?

INSPECT, SERVICE AND DESCRIBE THE OPERATION OF POWER BRAKE AND EMERGENCY BRAKE SYSTEMS.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  An operational power brake system incorporating a power brake control valve, shuttle valve and brake assembly, a brake sub-system accumulator, an emegency brake power system, debooster, hydraulic fuse and anti-skid device, a diagram or drawing of the entire system and written information describing the operation and servicing of the system.

- Performance:
  The student will identify the components of the system and label the diagram or drawing. Using the reference information, he will service and operate the system. He will describe the operation of power brake and emergency brake systems.

- Standard:
  Correct nomenclature and terminology will be used to describe the system operation and to label the diagram. Operation and servicing of the system will be in accordance with the reference information.

Key Points	*Feedback*
Power sources for power brake systems.	• What is the basic source of power for normal operation of a power brake system? • What is the power source for emergency operation of the brakes?
Brake deboosters.	• What is the purpose of a brake debooster in a power brake system? • Describe the hydraulic principle of debooster operation. • What reference publication would a mechanic use to determine the servicing procedure for a power brake system?
Brake sub-system accumulator.	• What is the purpose of an accumulator installed in the power brake system? • What feature of a brake sub-system accumulator installation prevents discharge of the brake accumulator into the main hydraulic system?
Power brake control valves.	• What is the purpose of the brake control valve? • What provision within the design of the control valve permits the pilot to "feel" the application of brake force?
Shuttle valves.	• What is the purpose of a shuttle valve? • What is the position of the shuttle valve during normal operation of the power brake system? • What is the action of the shuttle valve when emergency brake action is applied?
Brake fuses.	• What is the purpose of a brake fuse in a power brake system? • What is the position of the brake fuse in relation to the other components within the system? • Describe the principle of operation of an anti-skid device.
Emergency air bottle.	• What pressurized gas is most generally used for emergency brake operation? • How is the high pressure discharge of gas regulated as brake force is applied?

Activities	*Check Items*
	Did the student:
Identify the components in the system and label the diagram.	• Correctly interpret the reference information as an aid in identifying and labeling the diagram?
Describe the system operation.	• Use correct nomenclature throughout the description of operation?
Service and operate the system.	• Service and operate the system in accordance with the written instructions?

RECOGNIZE PROBABLE CAUSE OF BRAKE MALFUNCTIONS.

(SEGMENT I, LEVEL 2)

Student Performance Goal

- **Given:**
  The airplane manufacturer's service information, ten written statements describing brake fading, excessive pedal travel, grabbing brakes, spongy brake action and dragging and locked brakes.

- **Performance:**
  The student will describe the probable cause for each of the malfunctions described in the written statements.

- **Standard:**
  The student will provide at least one probable cause for each of the malfunctions. Information obtained from the manufacturer's service manual will be interpreted without error.

Key Points	*Feedback*
Malfunction in brake systems.	• What are some of the most common causes of fading brakes? • What are some of the factors which result in excess pedal travel? • What conditions within the system will probably result in grabbing brakes? • Describe how air will cause a spongy brake action. • What conditions will probably cause dragging brakes?

- What condition or conditions may result in locked brakes?
- If emergency air pressure has been used to stop an airplane, how are the brakes released so that the airplane may be moved?

Activities	*Check Items*
	Did the student:
Provide a probable cause for each of ten statements describing a malfunction of a brake system.	•Use and interpret information from the service manual? •Correctly relate malfunction and probable cause? •Use correct nomenclature as a part of the selection and explanation of probable cause?

BLEED AIR FROM A HYDRAULIC BRAKE SYSTEM.

(SEGMENT J, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's service instruction, appropriate bleeding equipment, supply of hydraulic fluids, and an operable hydraulic brake system into which air has been introduced.
- Performance:
  The student will bleed the system of air.
- Standard:
  The procedures specified in the service instructions will be followed without error or omission. The system, following bleeding, will be completely operational.

Key Points	*Feedback*
Methods of bleeding brake systems.	•Where would a mechanic find information detailing the procedure for bleeding the brakes on a specific airplane? •How should a mechanic determine the kind of hydraulic fluid that would be used to bleed a brake system? •What is the difference between gravity bleeding and pressure bleeding of a system?

- What should be the position of the parking brake during the bleeding operation?
- What problem will probably occur if the reservoir of the system is permitted to run dry while gravity bleeding the system?

Activities	*Check Items*
	Did the student:
Bleed a brake system using the gravity method. Bleed a brake system using the pressure method.	•Correctly interpret and follow the service instructions? •Select and use the correct fluid? •Achieve the desired operation standard?

SERVICE, REPAIR AND TROUBLESHOOT LANDING GEAR OLEO STRUTS.

(SEGMENT K, LEVEL 2)

Student Performance Goal

- Given:
  A completely assembled and operational shock strut (installed on an airplane or mock-up), the airplane manufacturer's service information,,replacement high pressure air valves and seals, hydraulic fluid, and appropriate tools and equipment to disassemble and inflate shock struts.
- Performance:
  The student will deflate a shock strut, drain the fluid, remove the piston from the cylinder, install seals, reassemble the strut, service with fluid, reinstall the air valve and inflate the strut. He will locate and interpret information from the service instructions and explain the probable causes of faults normally encountered in the operation of shock struts.
- Standard:
  The servicing procedures will be followed without deviation. The shock strut following service and repair will meet return-to-service standards. The service information pertaining to troubleshooting the strut will be interpreted without error.

Key Points	*Feedback*
Servicing shock struts.	•Where would a mechanic find information that specifies the correct inflation of a shock strut?

	• Why is nitrogen preferred to compressed air in the inflation of a shock strut? • What measuring points are commonly used to measure strut extension? • What physical features may be used to identify a high pressure air valve? • How would a mechanic determine the correct fluid level required for a shock strut?
Replacing shock strut seals.	• If a shock strut is leaking hydraulic fluid at the packing gland nut, what is the probable cause? • How could a mechanic determine the correct seal that is required as a replacement in a shock strut? • Describe some of the techniques that will avoid damaging a seal as it is moved past the threads of a shock strut. • Why are replacement seals lubricated before installation into the strut?
Troubleshooting shock struts.	• Describe some of the faults that might result in binding of a shock strut. • What would cause a shock strut to "bottom" during taxiing operations? • What are some of the causes of damage to a seal in a shock strut? • If a shock strut fails to extend following take-off, what is the problem? • What would probably result if a core type high-pressure air valve was installed with a common low pressure core assembly?

Activities	*Check Items*
	Did the student:
Select and install an air valve in a shock strut.	• Select a high pressure valve and follow the correct installation procedure?
Service the strut with fluid and inflate to service dimension.	• Correctly interpret service instructions and achieve return-to-service standards?
Install a replacement seal in a shock strut.	• Follow manufacturer's procedure for seal replacement?

DESCRIBE THE OPERATION OF AN OLEO SHOCK STRUT.

(SEGMENT L, LEVEL 2)

Student Performance Goal

- **Given:**
  Shock struts of the air-oil and spring-oil types, drawings of each type of strut and the manufacturer's service instructions; a matching type ten question examination pertaining to shock struts.
- **Performance:**
  The student will identify and label the components of each type of shock strut, explain the purpose of shock struts and describe the operation of both types of struts.
- **Standard:**
  Correct nomenclature will be used when labeling the drawings and describing the operation of the shock struts. Manufacturer's service information will be interpreted without error or omissions.

Key Points	*Feedback*
Air-oil struts.	• What is the function of the oil in the strut? • What is the reason for the high-pressure air or nitrogen in a strut? • What purpose is served by a metering pin and orifice in an oleo strut? • Where would a mechanic find information describing the disassembly procedure for a shock strut? • What is the function of a scissors or torque-link on a shock strut?
Spring-oil shock struts.	• What is the function of the spring in a plain oleo type shock strut? • Explain why the spring may be designed into the strut or located externally on the outside of the strut. • What types of seals may be used in a shock strut? • What is the purpose of the felt wiper which may be located between the piston and cylinder of a shock strut? • What feature in the design of a shock strut prevents the piston assembly from moving completely out of the cylinder of the strut?

Activities	*Check Items*
	Did the student:
Label the drawing of both air-oil and spring-out type shock struts.	• Correctly identify the piston, piston head, seals, packing gland nut, spring, high-pressure air valve, metering pin and orifice?
Describe the operation of both types of struts.	• Use correct nomenclature and terminology?
Answer ten question examination.	• Correctly interpret manufacturer's information?

OPERATE, INSPECT AND ADJUST A RETRACTABLE LANDING GEAR.

(SEGMENT M, LEVEL 3)

Student Performance Goal

- Given:
  An operational retractable landing gear (installed in an airplane or mock-up), written information or the manufacturer's service manual, an appropriate power source to permit operation of the gear, special tools and lubrication equipment as specified in the service information, mirrors, lights, measuring devices, etc.

- Performance:
  The student will operate the retractable landing gear, inspect and adjust the landing gear to meet return-to-service standards.

- Standard:
  The components of the landing gear need not be airworthy, but the adjustments and procedures outlined in the service manual will be followed within return-to-service limits.

Key Points	*Feedback*
Sequence of landing gear retraction.	• How could a mechanic determine the normal sequence of gear and landing gear door operation? • Why do some designs provide for extension of the main landing gear before the nose gear is extended? • Why may the nose gear extend before the main gear is extended? • What factors influence the selection of gear retraction methods, i.e., what are the advantages and limitations to the use of pure mechanical (lever), hydraulic and electric retraction?
Position indicators.	• What is the purpose of landing gear position indicating systems? • Describe some of the position indicating systems. • What are some of the advantages and limitations to pure mechanical (lever, visible pointer) and electrical indicating systems?
Inspection of retractable landing gear systems.	• What service information would guide the inspection frequency for a retractable landing gear? • What methods may be used as "landing gear down-locking" systems? What is a down-lock pin? What is an "over-center" down lock? • Why is the position of flexible hoses in a brake and hydraulic retraction system important? • Why is the fit of doors and fairings of a retractable landing gear system critical? • Describe some of the methods employed to lock a retractable type landing gear in the "up" position. • How is the gear up-lock and down-lock associated with the landing gear warning system? • Where would a mechanic locate information that specified the lubrication requirements for a retractable landing gear?
Operational checking of a retractable landing gear.	• Outline the safety precautions that should be observed when making a landing gear retraction check?
Lubrication and servicing.	• Where would the instructions for adjusting the landing gear limit switches or landing gear warning switches be located? • Where would information specifying the lubrication required for the landing gear be published? • How is the actuation of the landing gear safety switch related to landing gear retraction?

Activities	*Check Items* Did the student:
Operate a retractable landing gear.	•Use reference information to determine correct sequence of operation? •Correctly interpret reference information?
Inspect retractable landing gear assembly.	•Check strut extension? Chafing and interference? Actuation of locks, switches, etc.?
Adjust locks and switches to tolerances specified in the service manuals.	•Achieve the required tolerances following adjustment?

CHECK LANDING GEAR ALIGNMENT.

(SEGMENT N, LEVEL 2)

Student Performance Goal

- Given:
  An aircraft incorporating either a fixed or retractable landing gear, the airframe manufacturer's service information necessary to check landing gear alignment and the necessary measuring and alignment tools and equipment.

- Performance:
  The student will measure and record the caster, camber, toe-in and toe-out of the landing gear. Within the tolerance specified in the service information, he will judge whether the landing gear is acceptable for return-to-flight. If the alignment of the landing gear is unacceptable, he will interpret the service information and recommend the method that would return the gear alignment to acceptable limits.

- Standard:
  Service information will be correctly interpreted and procedure for measuring gear alignment will be followed without error.

Key Points	*Feedback*
Landing gear alignment.	•Describe why a misaligned landing gear may cause an airplane to "pull" to the side of the runway while it is being taxiied. •What are the factors that result in uneven tire wear? •How does landing gear alignment effect the control of an airplane during take-off and landing roll? •How is "toe-in and toe-out" of a landing gear wheel measured? •Where would information pertaining to landing alignment information be published? •How is the camber of a landing gear wheel measured? •What is caster of a wheel and how is it measured? •How could worn torque links or wear in the torque link bushings lead to uneven tire wear?

Activities	*Check Items* Did the student:
Measure and record landing gear alignment.	•Correctly use and interpret alignment information from the manual? •Record and correctly judge whether the alignment met tolerances? •Inspect tire wear as an indicator of gear alignment?

INSPECT, ADJUST AND SERVICE NOSE AND TAILWHEEL STEERING AND DAMPING MECHANISMS.

(SEGMENT O, LEVEL 3)

Student Performance Goal

- Given:
  An airplane or mock-up incorporating an operational nose wheel steering and dampener; an airplane or mock-up incorporating an operational tail wheel and shimmy dampener; the manufacturer's servicing information, tools and hydraulic fluids.

- Performance:
  The student will inspect, adjust and service both nose and tailwheel steering and damping mechanisms.

- Standard:
  Service information will be correctly interpreted. After servicing and adjusting the steering and damping mechanism will function as specified in the manufacturer's manual.

Key Points	*Feedback*
Steering mechanisms.	**•What sizes of airplanes may incorporate directly linked push-pull rods or cables to steer a nosewheel or tailwheel?** **•If the nosewheel is steered hydraulically why is a follow-up system generally included in the nosewheel steering mechanism?** **•What precautions are generally necessary to prevent damage to the steering systems when towing an airplane?** **•Why are steering limits usually marked on a nosewheel strut?** **•Where would information pertaining to a steering system be found?**
Shimmy damping mechanisms.	**•How does a hydraulic shimmy dampener prevent wheel shimmy?** **•In addition to hydraulic devices, what other devices are used to prevent shimmying?** **•Where would information pertaining to the servicing of a shimmy dampener be published?** **•How may a steering cylinder also serve as a shimmy dampener?**

Activities	*Check Items*
	Did the student:
Inspect and check a nosewheel steering mechanism.	**•Correctly use and interpret information from the manufacturer's service manual?**
Inspect and check a tailwheel steering system.	**•Follow the procedures specified in the manual?**
Service a shimmy dampener.	**•Achieve a standard that permitted normal functioning of the unit?**

POSITION AND WARNING SYSTEMS

8. INSPECT, CHECK, AND SERVICE SPEED- AND TAKEOFF-WARNING SYSTEMS, AND ANTISKID ELECTRICAL BRAKE CONTROLS. (EIT = 11 hrs., T = 5½ hrs., L/S = 5½ hrs.) 2 segments

(UNIT LEVEL 1)

PRINCIPLES OF OPERATION, INSPECTION AND CHECKS OF SPEED-, STALL-, AND TAKEOFF-WARNING SYSTEMS AND ANTISKID BRAKE CONTROL SYSTEMS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written information, visual training aids or diagrams, and multiple completion essay statements.

- Performance:
  The student will insert words to complete 20 multiple completion essay statements explaining the principles of operation and basic methods of installation of speed or mach-warning, stall-warning, takeoff-warning and electrical/hydraulic antiskid brake control systems.

- Standard:
  At least 14 statements will be completed correctly.

Key Points	*Feedback*
Speed-or mach-warning systems.	• Why is some method of special warning desirable when the airspeed exceeds a predetermined maximum? • Why is speed warning called mach-warning on most turbine aircraft? • What sensing methods are used for speed or mach-warning systems? • What inspection and checks are possible with the aircraft on the ground?
Stall-warning systems.	• What type of devices may be used for stall-warning? • Where can the information for inspecting and checking such devices be found?
Takeoff-warning systems.	• What is the primary purpose of a takeoff-warning system? • Which operational items may be tied into a takeoff-warning system? • Why may the warning be silenced for all or some of these items if desired? • What takeoff-warning inspection and checks are possible, on the ground, without engine or engines running?
Antiskid control systems.	• Why must an antiskid system be able to detect a skid at any wheel which has braking?
a. Skid detectors.	• What type of detector or sensor can be used to detect a skid at its starting instant? • What kind of signal is generated by a skid detector? • How is each skid detector mounted in its wheel and axle?
b. Antiskid computer.	• How is the signal carried from the detector to the central computer? • What does the computer do with the various signals from the skid detector? • When a skid starts, how does the computer react to it?
c. Electrical/hydraulic control units for braking.	• How is an electrical signal used to control the braking action when a skid is detected? • What is the resulting change in braking action when a skid has been sensed? • Does the antiskid system ever completely release braking on any wheels?
d. Cockpit controls and ground/flight tie-in.	• How is antiskid activated or armed from the cockpit? • How is operation of the antiskid system tied into the ground/flight change over switch or relay?
Inspection and checking of antiskid systems.	• To what extent can the operation of the antiskid system be checked on a parked airplane? • How can the skid detectors be inspected? Checked? • Where are the electrical/hydraulic control units usually located?

- How can they be checked?
- How can the tie-in between antiskid operation and ground/flight change over be checked on the ground?

SHOW SIMULATED OPERATION OF ANTISKID AND TAKEOFF-WARNING SYSTEMS.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- Given:
  Animated diagrams or simulation mock-ups of antiskid and takeoff-warning systems.

- Performance:
  The student will set up the various simulated switches, solenoids, and valves on an antiskid diagram for normal braking, then show by simulation what occurs when a skid develops on one wheel and on all wheels. On a takeoff-warning system diagram, he will set up the simulated switches for a normal takeoff, then show how a switch would cause takeoff-warning if flaps were not in proper takeoff position and show at least one other cause for takeoff-warning, on the diagram.

- Standard:
  At least one setup of switches for antiskid action will be correct and at least one cause for takeoff-warning will be properly shown.

Key Points	*Feedback*
Antiskid brake control system.	•Name the components which make up the antiskid system and the general location of each component. •How is the antiskid system activated electrically? •How is the antiskid system tied into the brake hydraulic system?
Takeoff-warning system.	•Name the components which make up the takeoff-warning system? •Which functions of aircraft operation are monitored for being correct for takeoff? •Which control movement in the cockpit will activate takeoff-warning when any of the monitored functions are not correct for takeoff?

Activities	*Check Items* Did the student:
On an animated diagram or simulation mock-up of an antiskid system, show switch settings, brake pedal positions, electrical and hydraulic valve action in brake control units, hydraulic flow paths and brake actions, electric flow paths from skid sensors to computer and return signals to brake control units, for normal braking and skid situations where one wheel is skidding and where all wheels are skidding.	•Show electrical power on and antiskid system armed? •Show airplane on ground by setting ground/flight switch to ground position? •Show brake hydraulic system correctly setup for brakes "on"? •Show proper action to release brakes partially on skidding wheel and its paired wheel? •Show brake action partially released to all wheels when skid was detected for all wheels?
On an animated diagram or simulation mock-up of a takeoff-warning system show normal take-off warning, then show how improper flap position will cause takeoff-warning to operate, and how at least one other improper condition will cause takeoff-warning to operate.	•Show ground/flight switch in ground position? •Show electrical power on? •Show takeoff-warning switches all open for a normal takeoff condition? •Show the related takeoff-warning switch closed when flaps are not in proper takeoff position, and on one other condition wrong for takeoff?

9. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR LANDING GEAR POSITION INDICATING AND WARNING SYSTEMS. (EIT = 9 hrs., T = 3 hrs., L/S = 6 hrs.) 1 segment

(UNIT LEVEL 3)

INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR A LANDING GEAR POSITION INDICATING AND WARNING SYSTEM.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's manual or equivalent written information, and aircraft or mock-up having retractable landing gear with a position indicating and warning system installed and operating.

- **Performance:**
The student will check the operation of the position indicating and warning lights by operating the landing gear, inspect the components of the position indicating and warning system, troubleshoot and repair different malfunctions introduced by the instructor, with each malfunction being corrected before the next is introduced. The malfunctions will include one which causes a false gear unsafe warning, two position light electrical malfunctions and one mechanical failure at a position indicating switch.

- **Standard:**
Locate and repair at least three of the malfunctions to a return-to-flight level in accordance with procedures provided.

Key Points	*Feedback*
Landing gear position indicating system.	•Why are separate gear safe green lights usually used, while the unsafe red light or lights apply to any gear? •Why is it better to use separate up and down lock switches than a single switch for both? •How are the position switches adjusted with relation to up- and down-locking of the gear?
Gear unsafe warning.	•How is provision made to give warning at anytime the gear is not locked up or down? •What additional provision is made to give warning if any gear is not in agreement with the other two gear? •How can the unsafe warning be checked on the ground with gear down and locked?

Activities	*Check Items* Did the student:
On an airplane or mock-up with retractable landing gear, check for proper operation of the position indication system and the unsafe warning.	•Make sure the airplane was properly and safely on jacks and the gear in the clear before operating it? •Make sure electric power was available and on for the system to be tested? •Inspect for condition of wiring and mounting?
Inspect and check operation of each component of the position indicating and unsafe warning system. Troubleshoot and repair four system malfunctions including one in the unsafe warning system, and two electrical and one mechanical malfunction in the position indicating system.	•Check operation of each switch for overtravel after actuation? •Use the appropriate circuit diagram when troubleshooting? •Use a voltohmmeter or test light to check continuity of wiring and switches? •Check lights for being operative and properly connected?

10. INSTALL INSTRUMENTS. (EIT = 11 hrs., T = 5 hrs., L/S = 6 hrs.) 2 segments

(UNIT LEVEL 2)

HANDLING AND STORING OF INSTRUMENTS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  A random display of aircraft instruments, including direct pressure indicating instruments, gyro instruments, temperature indicating instruments, compasses, and remote indicating indicators and transmitters; suitable cartons or storage containers, sealing plugs and shock absorbing shipping materials.

- **Performance:**
  The student will remove at least three instruments from the display panel or mock-up, seal all openings to the instrument, attach an identification tag and prepare the instrument for storage or shipment.

- **Standard:**
  The task of removing and identifying and preparing the instrument for storage or shipment will demonstrate precautions that will prevent further damage to the instrument.

Key Points	*Feedback*
Handling of instruments.	• Why should a mechanic exercise such extreme care when picking up and handling an aircraft instrument? • What damage may occur to a gyroscopic instrument if it merely rolls when it is placed on a bench or storage shelf? • What damage will probably result from over-tightening the mounting screws in the case of an instrument?
Preparation for storage or shipment.	• Why should all openings to the instrument be capped or sealed with tape? • What protection should be provided for the glass at the face of the instrument? • What may result if instruments are exposed to shipping vibrations and shocks?

Activities	*Check Items*
	Did the student:
Remove three instruments from a display panel, tag, seal and prepare for storage or shipment.	• Use correct tools and procedures during removal of the instruments? • Correctly identify and seal the instruments. • Provide adequate protection to avoid damage?

INSTALL INSTRUMENT PANELS AND INSTRUMENTS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  An airplane or mock-up provided with mounting brackets, an instrument panel, with instruments installed, appropriate panel shock mounts; written reference information describing the number, type, and load rating and procedure for installing the shock mounts and panel.

- **Performance:**
  The student will install the shock mounts, panel and instruments into the airplane or mock-up.

- **Standard:**
  The panel and instruments need not meet return-to-flight standards, but the installation of mounts, panel and instruments will fully comply with the written installation instructions.

Key Points	*Feedback*
Instrument panel hardware.	• What reference information would a mechanic use to identify the kind of hardware required for the installation of a panel of instruments? • What precautions apply to the routing of lines and wires behind the instrument panels? • What criteria should be applied to the selection of flexible hoses and clamps when installing instruments?

Panel shock mountings.	•What reference information would a mechanic use to determine the type, number and load rating of shock mounts? •Describe the factors that lead to rapid deterioration of instrument panel shock mounts. •Why must the shock mount specified for a particular instrument panel be used?
Installation procedures.	•Where would a mechanic find information detailing the location and procedure for installing an instrument panel and the associated instruments? •Where would a mechanic find information specifying the correct operating range markings for the instruments? •What precautions apply when threading the connecting fittings into the cases of the instruments?

Activities	*Check Items* Did the student:
Install shock mounts, instrument panel and instruments into the airplane or mock-up.	•Use and correctly interpret the installation instructions? •Use correct tools and procedures? •Avoid damage to the instruments and components?

11. INSPECT, CHECK, SERVICE, TROUBLESHOOT, AND REPAIR HEADING, SPEED, ALTITUDE, TIME, ATTITUDE, TEMPERATURE, PRESSURE, AND POSITION INDICATING SYSTEMS.

(EIT = 9 hrs., T = 4 hrs., L/S = 5 hrs.)
1 segment

(UNIT LEVEL 2)

INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR INSTRUMENT SYSTEMS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Manufacturer's service manuals or diagrams and written descriptions of a compass system, airspeed/altitude/rate of climb system, gyro attitude systems, temperature/pressure/positioning systems, appropriate operational instrument systems mounted in an airplane or mock-up.
- **Performance:**
  The student will inspect, check, service, troubleshoot and repair one system which has been made faulty by an action of the instructor.
- **Standard:**
  The student will interpret the written information, correctly identify and correct the fault in the system.

Key Points	*Feedback*
Heading indicators.	•What are some of the limitations of a magnetic compass? •What heading indicators may be provided to supplement the heading information available from a magnetic compass? •Where would a mechanic find information pertaining to the compass systems used on a particular airplane? •Describe the procedure for compensation of a magnetic compass? With what frequency is the accuracy of a compass checked? •What is a compass calibration card? •What precautions should be taken to minimize compass error induced by magnetic effects?
Pitot-static systems.	•Where would a mechanic find information detailing the procedures for inspecting, checking and servicing a pitot-static system? •What instruments are normally mounted and connected into the static line of the pitot-static system? •How would a leak in either the pitot or the static lines affect the operation of the individual instruments of this system?
Temperature indicating systems.	•Describe the principles of operation of a vapor-pressure type temperature indicating instrument.

	• How does a thermocouple device indicate temperatures? • What are the advantages and limitations to the use of electrical resistance type temperature indicators?
Pressure indicating systems.	• Describe how a Bordon tube responds to changes in external and internal pressures. • How does a diaphragm react to changes in internal and external pressures? • How does an aneroid react to changes in external pressures? • What reference information would a mechanic use when troubleshooting pressure indicating systems aboard the airplane?
Position indicating systems.	• Why is it necessary that a pilot have reliable indication of the position of gear, flap, and other controls? • When the gear or movable device is a great distance from the flight deck, what systems exist to indicate position of the control to the pilot? • How would a mechanic become familiar with the specific position indicating system in use?
Gyro system servicing.	• Where would a mechanic find information which describes the servicing of the vacuum system filters? • How could a mechanic determine the location of the filters in the gyro system? • What operating symptoms identify a clogged or obstructed gyro filter?

Activities	*Check Items* Did the student:
Operate the instrument systems available in the airplane or mock-up.	• Use and correctly interpret information available from the service manual?
Inspect, check, service, troubleshoot and correct one fault in one instrument system.	• Correctly isolate the system, identify the fault and correct the malfunction?

12. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR AIRCRAFT FUEL SYSTEMS.

(EIT = 13 hrs., T = 6 hrs., L/S = 7 hrs.)
2 segments

(UNIT LEVEL 3)

INSPECT AND SERVICE FUEL TANKS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Fuel tanks of the separate metal types, flexible bladder types and an integral type, appropriate service information and copies of the applicable Federal Aviation Regulations.

- Performance:
  The student will inspect each of the three different types of tanks. Using reference information, he will describe the construction characteristics, the installation and servicing precautions for each type of tank.

- Standard:
  The inspection will be accomplished as specified in the servicing manuals. Correct nomenclature and terminology will be used as a part of the description of construction, installation and servicing.

KeyKey Points	*Feedback*
Tank construction features: a. Baffles. b. Sumps. c. Strainers. d. Filler openings. e. Vents.	• Why are internal baffles designed into metal type fuel tanks? • Where are fuel tank sumps located in fuel tanks? • If the tank outlet fitting includes a finger type fuel strainer, what is the purpose of this strainer? • What markings are required on the filler cap or immediately adjacent to the filler opening of a fuel tank? • What FAA requirements govern the size and capacity of fuel sumps? • What are the requirements for venting a fuel tank? What may occur if the vent is obstructed? • Why is each fuel tank normally provided with a separate fuel drain? • If two or more fuel tanks may simultaneously supply fuel to an engine, what are the requirements for interconnected fuel vents? • What test pressures should be used to test a repaired fuel tank?
Tank installation.	• How are metal type fuel tanks anchored or attached to the airplane structure? • Why should fuel tanks be installed so that fuel loads are distributed over a wide area rather than concentrated at a local point? • Why is chafing and vibration a problem when installing separate type fuel tanks? • What are some of the problems generally associated with the integral type fuel cell? • How are flexible bladder type fuel tanks attached to the structure of the airplane? • If the fuel tank incorporates a submerged fuel boost pump, what special precautions should be observed when inspecting the tank? • Where would a mechanic find information detailing the repair of and inspections to be made of integral type fuel tanks?
Servicing of fuel tanks.	• Why should fuel tanks be "topped" following each flight rather than permitting the tank to remain in a partially filled condition? • Why shouldn't the filler nozzle of the refuelling hose be deeply inserted into the filler neck of a fuel tank? • What precautions should be observed if a chamois is used to filter fuel during refuelling?

Activities	*Check Items*
	Did the student:
Inspect a metal fuel tank. Inspect a bladder type fuel tank. Inspect an intergral type fuel tank. Describe construction features of each type of fuel tank. Describe the installation and servicing of each type of fuel tank.	•Correctly use and interpret reference information from the manufacturer's service manuals? •Use correct terminology and nomenclature as a part of all descriptions?

INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR FUEL VALVES AND FUEL PUMPS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An operational fuel system or test bench/mock-up, manually operated fuel valves, engine driven fuel pumps, wobble pumps, electrical fuel pumps, service information pertaining to operation and troubleshooting of fuel valves and pumps.
- Performance:
  The student will inspect, check, service, troubleshoot and repair each type of valve and pump.
- Standard:
  Each unit will function within the tolerance provided and be free of leaks and other hazards, but need not meet return-to-flight standards.

Key Points	*Feedback*
Fuel valves.	•Why does an aircraft fuel system usually incorporate a shut-off valve between the fuel tank and the engine? •Why must fuel selector valves be placarded or marked to indicate direction of flow or method of operation? •What are the requirements that govern crossfeed valves in the fuel system? •Why do fuel valves incorporate a detent or stop position to impart a "feel" to the valve position?
Fuel pumps.	•Describe the operation of a wobble pump. In what way does the mounting position of the pump effect the proper operation of the pump? •What are the factors that contribute to vapor locking of fuel pumps? •Describe a submerged type fuel boost pump. •How are booster pumps used when starting an engine? •What maintenance problems are related to the installation of boost pumps within the fuel tanks?

Activities	*Check Items*
	Did the student:
Inspect, check and service: a. Manually operated fuel valves. b. Engine driven, wobble and electric fuel pumps. Trouble shoot and repair: a. One fuel valve. b. One fuel pump.	•Use and correctly interpret information contained in the service manuals? •Correctly use tools and follow the prescribed procedures? •Identify the fault introduced by the instructor? •Accomplish a repair which permitted operation of the units within the tolerance provided in the service instructions?

13. REPAIR AIRCRAFT FUEL SYSTEM COMPONENTS. (EIT = 10 hrs., T = 5 hrs., L/S = 5 hrs.) 1 segment

(UNIT LEVEL 2)

INTERPRET INFORMATION PERTAINING TO REPAIR OF FUEL SYSTEM COMPONENTS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Typical aircraft fuel tanks of the separate metal types, flexible bladder types and integral type; fuel strainers, selector valves, fuel lines of the solid metal and flexible hose types, fuel drains, appropriate reference information, and ten written questions pertaining to repair of fuel system components.

- **Performance:**
The student will locate and interpret information from the manuals and describe the repair procedures for fuel system components as specified in the ten written questions.

- **Standard:**
The repair procedures will be interpreted without error. Correct nomenclature and terminology will be used as a part of all descriptions.

Key Points	*Feedback*
Repair of fuel tanks.	• What precautions and procedures are necessary when cleaning a fuel tank prior to accomplishing repairs to the tank? • What publication will provide information pertaining to the repair of the particular type of tank used in the airplane? • What publication will define the test pressures and describe the procedure to be followed when testing a repaired fuel tank?
Strainers.	• If strainers are provided at the fuel tank outlets, what Federal Air Regulations govern the size of these strainers? • What is the position of the main system fuel strainers with respect to other components in the fuel system? • What publications would provide information and instructions for servicing the screens in the fuel system?
Selector valves.	• Why are selector valves provided with placards and detents to provide a feel to the position of the selector valve? • If a fuel flow control valve is a simple "on-off" valve, how must the operation of this valve be placarded?
Fuel lines.	• What are the general conditions that dictate the minimum size of fuel lines that may be approved for an airplane? • What regulations govern the routing and location of fuel lines in relation to the electrical cables in the airplane? • What publications would provide information regarding repair of damaged fuel lines?
Fuel drains.	• What is the position of a fuel drain with respect to all other components of the fuel system? • What publication would contain information specifying the frequency at which fuel drains should be drained?

Activities	*Check Items* Did the student:
Answer the ten questions pertaining to repair of components of the fuel system.	• Locate and correctly interpret information contained in the manuals? • Use correct nomenclature and terminology as a part of the descriptions of repair?

14. INSPECT AND REPAIR FUEL QUANTITY INDICATING SYSTEMS. (EIT = 6 hrs., T = 3 hrs., L/S = 3 hrs.) 1 segment

(UNIT LEVEL 2)

INSPECT AND REPAIR FUEL QUANTITY INDICATION SYSTEMS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
An operational fuel quantity indicating system of the direct reading (sight gauge or mechanical float) and a remote indicating electrical type; appropriate reference information and ten statements describing malfunctions of the systems.

- **Performance:**
The student will inspect the operating systems, correctly interpret information from the manuals and describe the repair that would be undertaken to correct the malfunctions described in the ten statements.

- Standard:
  The repair practices and recommendations of the manual will be interpreted without error. Correct nomenclature will be used as a part of all described repairs.

Key Points	*Feedback*
Fuel quantity indicators.	• Why must the fuel quantity available be indicated to the pilot at all times? • What accuracy is normally anticipated with float type gauges? What accuracy is normal with electrical quantity gauges? • If the attitude of the airplane effects the indicated fuel quantity, what corrections are usually made in the indicating system? • Why do the fuel quantity indicating systems of most modern airplanes indicate fuel quantity by weight rather than by gallons? • Why do most large, multi-engined airplanes have remote indicating fuel quantity systems? • What publications would a mechanic refer to when it becomes necessary that he replace a component of the fuel quantity indicating system?

Activities	*Check Items* Did the student:
Inspect a direct reading fuel indicating system. Inspect a remote indicating fuel quantity system?	• Locate and correctly interpret information describing the inspection procedure?
Describe the repair procedure necessary to correct the malfunctions described in the ten statements.	• Use correct nomenclature when describing the repair practices? • Correctly identify the repair procedure?

15. INSPECT, CHECK, AND REPAIR PRESSURE FUELING SYSTEMS. (EIT = 2 hrs., T = 2 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

DESCRIBE THE INSPECTION, CHECKING AND REPAIR OF PRESSURE FUELING SYSTEMS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Visual aids, mock-ups and technical data as would be available from the manufacturer's service manual.

- Performance:
  The student will describe the procedures to be followed when inspecting, checking and repairing pressure type fueling systems.

- Standards:
  Reference publications will be used during the descriptions. Correct nomenclature and terminology is required as a part of the description.

Key Points	*Feedback*
Pressure fueling controls, indicators and warning lights.	• Using the reference information, describe the operation of the pressure fueling system. • What precautions must be observed before attaching the fueling nozzle to the airplane? • Should a static ground be attached when refueling an airplane with a pressure system or does this precaution apply only to an over-wing system? • What is a pitot valve in a pressure fueling system and what is its function? • What over-pressure safety devices are incorporated in a pressure fuel system and what is the purpose of these safety devices? • What publication would a mechanic use to determine the procedure necessary to repair a pressure type fuel system?

16. CHECK AND SERVICE FUEL DUMP SYSTEMS. (EIT = 1 hr., T = 1 hr., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

DESCRIBE THE CHECKING AND SERVICING OF A FUEL DUMP SYSTEM.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Visual aids and the technical data available from the manufacturer's service publications.

- Performance:
  The student will locate information in the reference publications and describe the checking and servicing of a fuel dump system.

- Standard:
  Correct nomenclature and terminology will be required as a part of the description.

Key Points	*Feedback*
Fuel dump systems.	• Under what conditions are fuel dump systems required by the Federal Aviation Regulations?
	• What methods may be employed to actuate the dump valves in the fuel system?
	• What publication should a mechanic use to determine the procedure for checking and servicing a fuel dump system?
	• With respect to safety of operation, how would a mechanic check the operation of a dump valve?
	• How is fuel flow maintained through the fuel dump system?
	• What special feature of a fuel dump system may be incorporated to prevent the discharge of a solid stream of fuel?

17. PERFORM FUEL MANAGEMENT, TRANSFER, AND DEFUELING.

(EIT = 2 hrs., T = 2 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

PERFORM FUEL TRANSFER AND DEFUELING.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Schematic diagrams or mock-ups of a fuel system that incorporates provisions for cross feed, fuel transfer and the service publications associated with the specific system.

- Performance:
  The student will locate information in the appropriate technical publication and describe the procedures necessary to transfer or cross feed fuel and defuel the system.

- Standard:
  Correct nomenclature and terminology will be used as a part of the description of operation.

Key Points	*Feedback*
Fuel management procedures.	• Describe how fuel management may be used to maintain the center of gravity of an operating airplane within closely defined limits.
	• What is the advantage of maintaining the center of gravity at a specific point?
	• What publication would a mechanic use to determine the procedure for transferring fuel?
	• How is fuel flow maintained within the fuel transfer system of an airplane?
Cross feed systems.	• What is the purpose of providing for cross feed of fuel in an airplane?
	• What are the hazards involved in cross feeding fuel?
Defueling procedures.	• Where would a mechanic find information describing the procedure to be followed when defueling an airplane?
	• What are some of the hazards associated with defueling?
	• If the airplane is being defueled, what is the importance of static grounding the airplane and defueling truck?

18. TROUBLESHOOT, SERVICE, AND REPAIR FUEL PRESSURE AND TEMPERATURE WARNING SYSTEMS.

(EIT = 2 hrs., T = 1 hr., L/S = 1 hr.) **1 segment**

(UNIT LEVEL 2)

TROUBLESHOOT, SERVICE, AND REPAIR FUEL PRESSURE AND TEMPERATURE WARNING SYSTEMS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  An operating fuel system installed in an airplane or on a mock-up, including a pressure and temperature warning system, a schematic or diagram of the system and the service information applicable to the specific system.

- Performance:
  The student will operate the system and adjust the pressure or temperature sensing devices. He will interpret information from the service information and identify the cause of an instructor introduced fault in the system. He will repair the system as directed in the service manual.

- Standard:
  All troubleshooting, servicing, and repair of the warning systems will be in accordance with the service publications. The information contained in the manuals will be interpreted without error.

Key Points	*Feedback*
Fuel pressure warning systems.	• Describe why a low fuel pressure would be cause for alerting the flight crew. • Why are annunciators used in some aircraft to indicate low fuel pressures rather than a simple red warning light? • What device is generally used to adjust and regulate fuel pressures? • What is the difference between fuel pressure and fuel flow?
Fuel temperature warning systems.	• Why is the temperature of the fuel a reason for concern? Is it the high temperature or low temperature that is being sensed and indicated? • What means are provided to control the temperature of the fuel? • What reference publication would a mechanic use to determine where the temperature sensing unit was located in the system?

Activities	*Check Items* Did the student:
Operate the fuel system and observe normal pressure and temperature warning system operation. Adjust pressure and temperature warning devices.	• Use and correctly interpret information from the service manual for the system? • Follow the procedure and correctly use the tools as specified in the maintenance manual? • Achieve an adjustment that was within the tolerance specified in the manual?

19. INSPECT, CHECK, AND SERVICE AUTOPILOT AND APPROACH CONTROL SYSTEMS. (EIT = 5 hrs., T = 5 hrs., L/S = 0 hrs.) 1 segment

(UNIT LEVEL 1)

PURPOSE AND OPERATING PRINCIPLES OF AUTOPILOTS AND APPROACH CONTROL SYSTEMS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Manufacturer's manuals, written information, and multiple completion essay statements.
- Performance:
  The student will complete 14 essay statements, by supplying missing words, concerning the purposes and operation of an autopilot, the operating principles of the sensing devices used to provide heading, attitude, and altitude information to the autopilot, the purpose and operation of servos or servomotors, the function of position transmitters and trim indicators, and the purpose and operation of an approach control system.
- Standard:
  Correctly complete 10 essay statements.

Key Points	*Feedback*
Basic types of autopilots.	• Compare the principles of operation of pneumatic/electronic and electric/electronic types of autopilots. • Discuss some advantages of each type and the type of airplane each is best suited for. • How many axes does each type provide sensing for?
Sensing devices used in autopilots.	• What is the operating principle of a gyro as the primary sensing device for an autopilot? • How can accelerometers aid in providing sensing signals to an autopilot? • How may the earth's magnetic flux be used for heading sensing for an autopilot?
Purposes of a servo or servomotor.	• How does a pneumatic servo operate a flight control? • How does a two-phase electric servomotor operate a flight control? • What is the purpose of feedback and rate control in a servo system?
Installation requirements for an autopilot system.	• Where will the detailed installation requirements for an autopilot be found? • What is the importance of the gyro unit of an autopilot? • Why is the location and mounting of sensing units very critical?
Position transmitters and trim indicators.	• What is the function of a position transmitter and its related trim indicator? • How can the trim indicators be used to check autopilot operation?
Altitude hold and approach control functions of an autopilot.	• What is the value of the altitude hold function? • Why must the altitude hold be disengaged during climb and descent? • What is the function of approach control? • What additional signal sensing does it use?

20. INSPECT, CHECK, AND SERVICE AIRCRAFT ELECTRONIC COMMUNICATION AND NAVIGATION SYSTEMS. (EIT = 5 hrs., T = 5 hrs., L/S = 0 hrs.) 2 segments

(UNIT LEVEL 1)

TYPES AND INSTALLATION OF AIRCRAFT ELECTRONIC COMMUNICATIONS AND NAVIGATION EQUIPMENT.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  AC 43.13–1, AC 43.13–2 or equivalent published information, and questions with multiple choice answers.

- **Performance:**
  The student will select answers for 20 questions concerning electronic communications and navigation systems. The questions will deal with types of equipment used in various aircraft, where and how the equipment is mounted, cooling, and reduction of electrical interference.

- **Standard:**
  Select at least 14 correct answers.

Key Points	*Feedback*
Electronic communications systems.	• What types of radio communications equipment are commonly used? • What types of inter-communication systems are used in large passenger aircraft?
Electronic navigation systems.	• What types of electronic navigation equipment are likely to be found in small aircraft? • Name some additional navigation systems used in large aircraft which are electronically operated.
Electronic equipment installation and mounting.	• What are some advantages of electronic racks or compartments over widely scattered installations? • How critical is adequate cooling for electronic equipment? • Why is shock mounting needed for most electronic equipment? • Where can specifications be found for shock mounting of radio and other electronic equipment?
Reducing engine noise and other electrical interference in radio receivers and communication systems.	• What part does shielding play in reducing electrical interference? • How should the shielding be bonded to structure of the aircraft? • How are filters used in helping reduce interference?

FCC REGULATIONS PERTAINING TO TWO-WAY RADIO OPERATION.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- **Given:**
  FCC regulations pertaining to aircraft radio operation, or an equivalent publication and questions concerning these regulations.

- **Performance:**
  The student will write answers to 10 questions concerning the operation of aircraft and ground radio transmitters, FCC regulations pertaining to radio transmissions, acceptable practices and vocabulary useage, proper recognition and acknowledgement techniques and rules covering display of licenses.

- **Standard:**
  Correct answers for at least 7 questions.

Key Points	*Feedback*
FCC license requirements.	• What is the minimum license a person must hold to be permitted to operate an aircraft transmitter? • What further license must be on display in the aircraft near the transmitter? • What are the license requirements relative to radio transmitters in ground equipment or of walk-around type?
FCC regulations covering transmission techniques.	• Why should the frequency always be monitored before starting a transmission? • Why should all transmissions be concise, brief, and clearly spoken? • What calling procedure will assure that the person called knows he is being called and who is calling him? • What procedure is used to acknowledge that a message has been received and understood? • What kinds of words or transmitted information are forbidden? • What are the restrictions about adjusting or repairing radio transmitters?

21. INSPECT AND REPAIR ANTENNA AND ELECTRONIC EQUIPMENT INSTALLATIONS.

(EIT = 10 hrs., T = 5 hrs., L/S = 5 hrs.)
2 segments.

(UNIT LEVEL 2)

REPAIR OR REPLACE AIRCRAFT ANTENNAS AND RELATED ELECTRONIC EQUIPMENT.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Manufacturer's manuals, AC 43.13–1, AC 43.9–1A, AC 43.13–2 or equivalent publications, an aircraft or mock-up with electronic installations which use fixed wire, blade or whip, and flush mounted antennas, and questions with multiple choice answers pertaining to FAR procedures after a major repair or alteration has been accomplished.

- Performance:
  The student will locate repair and replacement information for a fixed wire antenna, a blade or whip antenna, and a flush type antenna. Using this information, he will replace one antenna and related electronic equipment and repair one other antenna which has been intentionally damaged by the instructor. He will select answers to 6 questions pertaining to FAR requirements for returning an aircraft to service after a radio installation has been made in accordance with approved data.

- Standard:
  Locate proper information and perform replacement and repairs in accordance with published procedures and specifications for return-to-flight. Select correct answers for at least 5 questions.

Key Points	*Feedback*
Repair or replacement information for electronic equipment installations.	• Where are specifications and procedures for radio installations to be found? • Why is the installation of a radio and antenna considered as a major alteration of an aircraft? • Why are repairs to antennas considered as critical work items?
Conditions to be considered in the installation of a radio in an aircraft.	• What are the considerations in locating the radio unit and its control unit? • Why must the antenna installation conform to the manufacturer's specifications as to type and location?
FAR procedures for returning an aircraft to service after a radio installation.	• What advisory circular specifies what must be done to return an aircraft to service after a major repair or alteration? • Who is responsible for carrying out these procedures?

Activities	*Check Items* Did the student:
Replace an antenna and related electronic equipment in an aircraft or mock-up.	• Locate and follow procedures specified by the manufacturer? • Use proper precautions to avoid damage to the equipment? • Check for proper operation upon completion of replacement?
Repair an antenna installation intentionally damaged by the instructor.	• Inspect for condition and extent of damage? • Follow repair procedures in manual provided? • Use suitable tools and material in making repairs? • Check for proper operation after completion of repairs?

IDENTIFY AND DESCRIBE PURPOSE OF STATIC DISCHARGERS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Written information, AC 43.13–1 or equivalent publication, sample static dischargers on an aircraft or mock-up and drawings of static dischargers which include carbon impregnated braid types, metallic braid types, null-field types, and an ohmmeter.

- Performance:
  The student will identify each of the three types of static dischargers and write a brief description of how each type performs its intended function. He will also describe how each type is to be inspected and what wear or damage indications require repairs or replacement and then will inspect the mounting and test the epoxy bond resistance.

- **Standard:**

  At least two identifications, two descriptions of functions and two descriptions of repair procedures will be correct, in accordance with information provided.

Key Points	*Feedback*
Static dischargers.	**• Where are static dischargers located on an airplane?**
a. Causes of corona static.	**• Why are they used mainly on metal aircraft?**
b. Function of dischargers.	**• Contrast the function of a static discharger with a lightning rod.**
Types of dischargers. **a. Carbon wick.**	**• What purpose does the vinyl covering serve on the carbon impregnated braid?**
b. Metallic braid. **c. Null-field.**	**• How important is the length of the braid in a metallic braid discharger?** **• What purpose do the points serve in null-field dischargers?** **• How are null-field dischargers attached to the airplane surfaces?**

Activities	*Check Items*
	Did the student:
Identify the following types of static discharger from a sample or drawing of each: **a. Carbon wick.** **b. Metallic braid.** **c. Null-field.** **Write a brief description of how each type functions to discharge static buildup from the wings.** **Write a description for each type of wear and damage to look for when inspecting, and whether repairs or replacement are called for in each case.**	**• Identify each type with a label?** **• Tell the purpose of the wick or braid where used?** **• Describe what the points do in the null-field type?** **• Describe how each type should be mounted?** **• Perform inspection of mounting and a test of electrical resistance across the epoxy bond?** **• Perform inspection of braid for wear and abrasion?** **• Perform inspection of points in null-field type dischargers?**

CABIN ATMOSPHERE CONTROL SYSTEMS

22. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR HEATING, COOLING, AIR CONDITIONING, AND PRESSURIZATION SYSTEMS.

(EIT = 14 hrs., T = 14 hrs., L/S = 0 hrs.)

4 segments

(UNIT LEVEL 1)

THE PRINCIPLES OF OPERATION AND CONTROL OF CABIN PRESSURIZATION.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written information, schematic diagrams and questions with multiple choice answers concerning aircraft cabin pressurization.

- Performance:
  The student will select answers for 14 questions concerning the basic principles of cabin pressurization and how it is controlled, the relationships of cabin pressure to ambient pressure during a flight, the purposes and operation of check valves in delivery air ducts, outflow valves, emergency relief valves, and negative pressure relief valves.

- Standard:
  Select correct answers for at least ten questions.

Key Points	*Feedback*
Structural provisions for cabin pressurization.	•How must the fuselage structure be designed if it is to be pressurized? •How much negative pressure will it be expected to withstand? •What portion of the fuselage is generally included in the pressurized area? •How tight must the pressurized portion of the fuselage be? •Why can a certain amount of leakage be tolerated?
Sources of pressurizing airflow.	•How can a supercharger or compressor be designed to maintain a relatively constant volume of airflow under varying rates of drive? •What safeguards are needed to protect against overspeed and overheat in a compressor? •If air is bled directly from turbine engines for air conditioning and pressurization, how is the pressure and temperature of the bled air kept at a safe level?
Air delivery system.	•Describe the general ducting of the air from the compressor to the mixing valve and into the cabin and cockpit. •What is the purpose of check valves in the delivery ducts from the air sources? •How is the air leaving the cabin and cockpit routed to the outflow valve or valves?
Outflow valves.	•What is the main purpose of the outflow valves? •How may a jet pump be used to provide vacuum for muscle power to operate the outflow valves. •Should the outflow valve be open or closed when the airplane is parked?
Emergency relief valves.	•Why are emergency relief valves needed? •At what relative cabin pressure will they start opening automatically? •What condition would call for the emergency valves to be opened manually when pressure is below maximum?
Negative pressure relief valve.	•Why is a negative pressure relief valve a necessity for a pressurized aircraft? •At what negative pressure will the valve open? •Where is the negative pressure relief valve usually located?
Cabin pressure control.	•What unit is operated by the cabin pressure control system to change cabin pressure? •Which two pressure are sensed for basic cabin pressure control?

a. Automatic rate-of-climb cabin pressure control system.	•On what principle does a rate-of-climb automatic pressure control system operate? •Why is the safe rate-of-climb greater than the safe rate-of-descent in cabin pressure control? •How does the rate-of-climb in cabin pressure relate to aircraft rate-of-climb?
b. Automatic ratio cabin pressure control system.	•How does a ratio system differ from a rate-of-climb system? •How critical is the initial setup and flight plan in a ratio system?
Manual cabin pressure control.	•Why is manual control usually used only as a backup for the automatic system? •How can the manual system be of help in checking cabin pressurization operation? •What precautions should be taken when checking pressurization with manual control to protect the ears of those in the aircraft?

THE FUNCTIONS AND PRINCIPLES OF OPERATION OF AIRCRAFT AIR CONDITIONING.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- Given:
  Written information and diagrams of an aircraft air conditioning system.

- Performance:
  The student will write a brief description of the functions of each of the following components in an air conditioning system: the supercharger or compressor, the mixing valve, the intercooler or primary heat exchanger, the passenger's cold air distribution system, cabin and duct sensors, ambient air sensor, main distribution ducts, cabin air inlet louvers, cabin air exhaust outlets, outflow valve, recirculating fan, and ground blower.

- Standard:
  At least eight descriptions will be in accordance with information provided.

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Key Points	*Feedback*
Functions of an air conditioning system.	•In a pressurized airplane, what are the three major functions of the airflow system for the cabin and cockpit? •Which two functions are needed in all closed fuselage aircraft? •How does the capacity of the air conditioning system relate to the passenger capacity of the aircraft?
Cabin supercharger or compressor.	•Why is some form of compressor required for a non-turbine engine pressurized aircraft?
Cabin mixing valve and temperature control.	•What three types of air are available for mixing? •How is the mixing valve designed so that hot and cold air are never mixed with tempered air at the same time? •How fast does a mixing valve operate? •What controls the mixing valve actuator? •How can it be controlled if the automatic control system fails?
Cockpit airflow and temperature control.	•What proportion of the total airflow is needed for the flight compartment? •Why is adequate ventilation of the cockpit related to electronic rack cooling in many airplanes?
Air conditioning functions of the outflow valve.	•How much of the ventilation air is exhausted through the outflow valve? •Why can it never be allowed to completely close? •How can cabin air be obtained from turbine powered aircraft engines without using separate compressors?
Air distribution ducts.	•Describe the basic ducting system for a large cabin plane. •Describe the ducting system for a small cabin plane. •How is ventilation obtained in case of failure of the compressor system?

	How is exhaust air routed away from the cabin?
Cold air distribution system.	Why is a separate cold air distribution system desiable? Where are the cold air inlets for passengers? How is enough differential pressure maintained to keep cold airflow always available? What will be the effect on ventilation and temperature in the cabin, if outflow valve has failed in a nearly closed position?
Recirculating fans and ground blowers.	What is the primary purpose of a recirculating fan in an air conditioning system? What is the function of a ground blower? How may a recirculation fan be used to replace a ground blower? Why is no ground blower needed on an aircraft with an APU?

THE INSPECTION, CHECKING AND TROUBLESHOOTING OF AIRCRAFT COMBUSTION HEATERS AND EXHAUST-TYPE HEAT EXCHANGERS.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- Given:
  Written information and questions with multiple choice answers concerning aircraft surface combustion heaters and exhaust-type heat exchangers.
- Performance:
  The student will select answers for ten questions with regard to surface combustion heater operating principles and troubleshooting, exhaust-type heat exchanger operation and troubleshooting, inspection requirements of cabin heating systems.
- Standard:
  Select correct answers for at least seven questions.

Key Points	*Feedback*
Surface combustion heaters.	What type of fuel is used in aircraft combustion heaters? What are the basic principles of operation of thermostatically controlled surfaces combustion heater? Why is some form of air/fuel mixture regulation necessary?
Exhaust-type heat exchangers.	Compare the advantages and disadvantages of exhaust-type heaters with combustion heaters. How is ambient air routed through an exhaust-type heater for hot air delivery? How can the hot air output from an exhaust-type heat exchanger be thermostatically controlled?
Cabin and cockpit heating.	How can a surface combustion heater be used to heat the cabin and cockpit? How can an exhaust-type heat exchanger be used to heat the cabin and cockpit?
Protective features for heater control circuits.	What protective features are included in the control circuits of combustion heaters? Why are heat control switches backed up by overheat switches? What control features are incorporated in cabin and cockpit temperature control circuits to prevent excessive heating from the heater?
Precautions and hazards in use of heaters.	Why must the exhaust of a combustion heater be isolated from any leakage into the heated airflow? Why does the same precaution apply to the engine exhaust in an exhaust-type heat exchanger? What malfunctions could cause drowsiness of pilot or passengers?
Inspection and troubleshooting of aircraft heaters or heat exchangers.	What are several inspection points for a combustion heater? What are several inspection points of an exhaust-type heat exchanger?

	• What are the inspection requirements of a cabin heating system utilizing heat from an exhaust-type heat exchanger?
Methods of checking combustion heaters.	• What checks can be performed for detecting leaks in a combustion heater fuel system? • What checks can be performed for detecting leakage from the heater exhaust into the heated air? • How can the heater control system be checked when the airplane is parked?

THE CHECKING AND TROUBLESHOOTING OF AIRCRAFT VAPOR-CYCLE AND AIR-CYCLE COOLING SYSTEMS.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- Given:
  Written information, unlabeled diagrams, and completion type essay statements relative to aircraft vapor-cycle and air-cycle cooling systems.

- Performance:
  The student will inspect labels in spaces provided to identify components in diagrams of a freon vapor-cycle aircraft refrigeration system and an air-cycle aircraft cooling system. He will complete essay statements concerning freon system components, air-cycle machine components, and checking, troubleshooting and servicing aircraft cooling systems.

- Standard:
  Correct labels and completion words for at least 70 percent of the spaces provided.

Key Points	*Feedback*
Aircraft cooling systems.	• Why is some form of cooling needed for the cabin and cockpit air in a pressurized aircraft?
a. Purpose.	• How is ambient air used to aid in the cooling? • Which is least important in a large pressurized aircraft: a heater or a cooling system?
b. Freon vapor-cycle refrigerating systems.	• What are the major components of an aircraft freon cooling system? • What is the function of each major component? • Describe the location in relation to each other of the units in a freon vapor-cycle system. • What is the procedure for servicing a freon cooling system which has lost all of its freon charge?
c. Air-cycle cooling systems.	• What are the basic principles of an air-cycle cooling system? • How does an expansion turbine lower the temperature of the air it handles? • What is provided to keep the output air from dropping below freezing?
Troubleshooting of cooling systems.	• How can the cooling system of a pressurized aircraft be checked without engines operating? • Will an APU usually be adequate for this? • Where will troubleshooting procedures be found for the cooling system of any specific aircraft?

23. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR OXYGEN SYSTEMS. (EIT = 7 hrs., T = 3 hrs., L/S = 4 hrs.) 1 segment

(UNIT LEVEL 2)

INSPECT, CHECK, AND SERVICE OXYGEN SYSTEMS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Manufacturer's service manual or equivalent written information, check sheet or work card, an aircraft or mock-up with an operative oxygen system.

- Performance:
  The student will check the oxygen system for leakage, check bottle pressure and replace a high pressure oxygen bottle, check oxygen system pressure, inspect oxygen masks for contamination and check an oxygen mask and regulator for proper operation.

- **Standard:**
  All performance will be in compliance with the check sheet or work card provided.

Key Points	*Feedback*
Necessity for oxygen.	•Discuss effects of high altitude on people (anoxia). •What is the approximate cabin altitude above which oxygen is considered to be needed? •Why are flight crew members required to use oxygen at a lower altitude than required for passengers?
Types of oxygen systems.	•What is the difference between a cabin oxygen system and an individual passenger oxygen system? •What type of oxygen bottles are used for individual passenger oxygen systems? •What type of bottles are used for flight crew oxygen? •How are the flight crew and passenger oxygen systems interconnected in most aircraft?
Oxygen handling precautions.	•What are the hazards of oil, grease or fuel in any of the fittings of high pressure oxygen systems? •What is the importance of making sure oxygen bottles are fully shut off before removing connecting lines? •Why should oxygen bottles be handled with care and stored in cool isolated locations?

Activities	*Check Items*
	Did the student:
Check an oxygen system on an aircraft or mock-up for leakage. Check bottle pressure and replace a high pressure oxygen bottle. Check oxygen system pressure after replacing bottle. Inspect oxygen masks for contamination.	•Use soap and water for leakage test? •Inspect fittings for cleanliness from grease or oil? •Read bottle pressure, then shut down pressure completely before removing fittings? •Make sure all fittings were clean before connecting?
Check operation of an oxygen mask and regulator.	•Use clean dry tools and wipe hands with a clean cloth? •Wipe out masks with a clean dry cloth? •Check setting of the regulator as specified on the placard? •Complete all items on check sheet or work card?

24. REPAIR HEATING, COOLING, AIR CONDITIONING, PRESSURIZATION AND OXYGEN SYSTEM COMPONENTS. (EIT = 9 hrs., T = 9 hrs., L/S = 0 hrs.) 3 segments

(UNIT LEVEL 1)

IDENTIFY COMPONENTS OF AN AIRCRAFT COMBUSTION HEATER, FREON COOLING SYSTEM, AND AN AIR-CYCLE EXPANSION TURBINE.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information, unlabeled cut-away drawings, and questions with multiple choice answers.

- **Performance:**
  The student will identify and label the following items in a cut-away drawing of a surface combustion heater: fuel and combustion air inlets, ventilating air inlet and outlet, exhaust, fuel nozzle, spark plug, overheat and drop-out thermal switches; and show flow patterns by arrows. He will identify and label the major components of a freon vapor-cycle cooling system. He will identify and label the following items in an air-cycle cooling system: turbine air intake and outlet, turbine, axial flow fan, fan air intake and outlet, oil reservoir, bearing and oil wick, primary and secondary heat exchangers, and show air routings through the turbine, heat exchangers and fan outlet section.

- **Standard:**
  Correct labels and arrows for at least 70 percent of the specified items.

Key Points	*Feedback*
Fuel and air flow patterns in a surface combustion heater.	•Why are separate air inlets provided for combustion and ventilation air? •How is the fuel flow regulated by the combustion air flow?

	• How is heat transferred from the combustion chamber to the ventilating air?
Heater ignition.	• How are spark plugs installed and how is high voltage provided for them?
Control sensors and overheat protection.	• Where are control sensors or switches located in relation to overheat and cut-off switches? What are the relative temperature settings? • What protection is provided around the combustion exhaust outlet to protect surrounding material and equipment?
Freon vapor-cycle cooling system components and servicing.	• How is coolant air obtained for the condenser and how is it controlled? • How is the liquid level determined in the freon reservoir? • What are the usual sources of contamination in a freon system? • What is a method of protecting the freon system from contamination during component replacement? • How is a freon system recharged when the liquid level is low?
Expansion turbine air-cycle cooling system components and servicing.	• How are the turbine and axial-flow fan coupled together? • What type of lubrication is provided for the shaft bearing? • How is the oil level checked and how is oil added?

REPAIR OR REPLACEMENT PROCEDURES FOR AIR CONDITIONING AND PRESSURIZATION COMPONENTS.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- Given:
  Manufacturer's service manuals or equivalent written material and samples or drawings of air condition and pressurization system components.

- Performance:
  The student will identify samples or drawings of the following components and list reference page numbers for repair or replacement information for ten of the components identified: cabin supercharger or compressor, air delivery duct check valve, cabin air mixing valve and its actuator, cabin temperature control unit and instruments, outflow valve, and actuator, pressure control unit and instruments, automatic and manual emergency relief valves, cabin ground blower, recirculation fan, and cabin vacuum (negative pressure) relief valve.

- Standard:
  Correctly identify at least ten components and list correct reference page numbers for repair or replacement information for at least 7 components.

Key Points	*Feedback*
Sources of repair or replacement information for air conditioning and pressurization components.	• Which manuals provide information as to line repairs of air conditioning and pressurization components? • Why are such components usually replaced, rather than repaired, when malfunctioning or inoperative? • When repairs are specified, where are part numbers, for needed parts, to be found?

REPAIR OR REPLACEMENT PROCEDURES FOR AIRCRAFT OXYGEN SYSTEM COMPONENTS.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- Given:
  Manufacturer's service manuals, AC 43.13–2, or equivalent publications, samples or drawings of oxygen system components and multiple choice questions.

- Performance:
  The student will select answers to ten questions dealing with repair or replacement of oxygen system components, including oxygen high pressure bottles and regulators, walk around oxygen bottles and regulators, flight crew oxygen masks and flow regulators, passenger oxygen masks and therapeutic oxygen equipment.

- **Standard:**
  Select 8 correct answers.

Key Points	*Feedback*
Oxygen system trouble symptoms and checks.	**• What indication would there be if an oxygen system is leaking in the plumbing between bottles and outlets?** **• What can cause insufficient regulated flow to an oxygen mask?** **• What steps must be taken before replacing a malfunctioning flight crew oxygen regulator?** **• How should the replacement regulator be checked?**
Checking walk-around and therapeutic oxygen equipment.	**• What checks should be made of a walk-around oxygen unit to assure it is operating properly?** **• How can a therapeutic oxygen outlet be checked for proper operation?**

ICE AND RAIN CONTROL SYSTEMS

25. INSPECT, CHECK, TROUBLESHOOT, SERVICE, AND REPAIR AIRFRAME ICE AND RAIN CONTROL SYSTEMS. (EIT = 12 hrs., T = 4 hrs., L/S = 8 hrs.) 2 segments

(UNIT LEVEL 2)

PRINCIPLES OF INSTALLATION, OPERATION AND CHECKING DEICING AND ANTI-ICING SYSTEMS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Manufacturer's information or equivalent publications containing illustrations, diagrams, operating and maintenance information concerning deicing and anti-icing systems, and questions with multiple choice answers.

- Performance:
  The student will select answers to 20 questions dealing with operating principles safety precautions and checking of deicer boots, leading edge heated air anti-icing systems for airfoils and intake ducts, and electrically operated anti-icing for air intake ducts and ports.

- Standard:
  Select at least 14 correct answers.

Key Points	*Feedback*
Deicer boot systems.	•On what portions of an aircraft would deicer boots be used?
a. Pneumatic type.	•Where is the pneumatic pressure usually obtained for airfoil deicer boots? •Why has the use of bonding agents generally replaced the use of Riv-nuts for deicer boot installation. •What are the operating principles of pneumatic deicer boots? •Describe the procedure for checking deicer boot operation.
b. Carbon impregnated electrical type.	•Where are carbon impregnated electrical deicer boots used? •Why is the electric power cycled to different boots rather than to all at once? •What is the purpose of the timer? •How can minor damage be repaired in propeller deicer boots?
Anti-icing systems.	•What are the principal differences between anti-icing and deicing?
a. Airfoil leading edge heated air systems.	•How is a wing or stabilizer leading edge designed to make possible anti-icing with heated air? •When should the anti-icing heating be started relative to an anticipated icing condition? •How can the operation of wing or tail anti-icing be checked on the ground? •What precautions should be taken when checking or operating heated air anti-icing on the ground? •Describe the sources for anti-icing heated air in specific types of aircraft.
b. Air scoop and intake duct leading edge heated air anti-icing.	•How is heated air used to prevent icing of engine air intakes? •What other types of air scoops or air intakes may use heated air to prevent icing?
c. Electrically operated anti-icing for air intakes and ports or vents.	•Why is electrical anti-icing often more practical for small air intakes and ports? •Why is some form of ice prevention needed for instrument air intake or pressure sensing air vents? •What precautions are necessary when checking electrical anti-icing on the ground?

REPLACE, INSPECT AND CHECK OPERATION OF ELECTRICALLY OPERATED AIR SCOOP AND PITOT STATIC OR STATIC VENT ANTI-ICING.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Written information, schematic diagrams, an aircraft or mock-up with electrically operated anti-icing for an air scoop and an air inlet port.
- Performance:
  The student will locate appropriate work procedures, remove, inspect and replace the following: an electrical air scoop leading edge, anti-icing component and an electrical anti-icing element for a pitot tube or static air vent and complete a work sheet showing work accomplished.
- Standard:
  Procedures followed in accordance with information provided and anti-icing components reinstalled and operative at return-to-service standards and proper safety precautions adhered to in addition to proper entry in log book.

Key Points	*Feedback*
Operation and replacement of electrically operated anti-icing components.	•How is the electrical power provided? •Why is ground operation limited even when external electrical power is available? •What type of heating element is used for air scoop leading edge anti-icing? •What types of heating elements are used for pitot tube heating and static air vent heating?
Precautions and check procedures.	•What precautions should be taken when replacing electrical heating components? •How can the elements and connections be checked? •What evidences of malfunction should be looked for during inspection?

Activities	*Check Items* Did the student:
On an aircraft or mock-up, remove, inspect and replace an electrical heating component for air scoop leading edge anti-icing and an electrical heating element or component for pitot tube anti-icing or static air vent anti-icing. Check operation of both units and sign-off work sheets showing work accomplished. Complete log book entry.	•Locate and use appropriate work procedures? •Make sure electric power was off and the component was not hot before starting removal? •Inspect electrical connections and elements for evidence of arcing or overheating? •Check resistance element, if any evidence of malfunction was apparent? •Follow procedures while reinstalling components? •Make suitable entries on work sheets?

26. INSPECT, CHECK, AND SERVICE SMOKE AND CARBON MONOXIDE DETECTION SYSTEMS.

(EIT = 1 hr., T = 1 hr., L/S = 0 hrs.) **1 segment**
(UNIT LEVEL 1)

PRINCIPLES OF OPERATION OF SMOKE AND CARBON MONOXIDE DETECTORS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written information and completion type essay statements concerning photo-electric and visual smoke detectors and chemical type carbon monoxide detectors.

- Performance:
  The student will complete six statements concerning how smoke is detected by photo-electric and visual methods, how air sampling is accomplished for smoke detection, and uses of chemical type CO detector buttons.

- Standard:
  Correctly complete at least four statements.

Key Points	*Feedback*
Methods of smoke detection.	• Where is smoke detection needed?
a. Photo-electric method.	• If smoke is drawn between a light source and a photo-cell, what effect will it have on photo-cell output? • Why will accumulated soot and dust cause false smoke warnings? • What steps have been taken to eliminate the need for smoke detectors in baggage and cargo compartments?
b. Visual method of smoke detection in air freighters.	• Why is smoke detection needed in an air freighter? • How is air sampling accomplished in air freighters? • How can a light beam be used to detect smoke particles in the sampled air? • How can a visual type smoke detection system be checked for proper operation by use of a cigarette?
CO detectors.	• What happens to a CO detector button when CO is present? • Why is the detection of CO more critical in a private single engine aircraft than a multi-engine commercial airliner?

27. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR AIRCRAFT FIRE DETECTION AND EXTINGUISHING SYSTEMS.

(EIT = 11 hrs., T = 4 hrs., L/S = 7 hrs.) **3 segments**
(UNIT LEVEL 3)

INSPECT, CHECK, TROUBLESHOOT AND REPAIR FIRE DETECTION SYSTEMS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's information or equivalent written information, samples or cutaway drawings of fire detectors and a mock-up with at least one type of operative aircraft fire detector system.

- Performance:
  The student will write a brief description of the method of operation for each of the following types of fire detectors: thermal switch, thermocouple and continuous loop. On a mock-up, he will trace the circuit of a fire detection system and activate the system alarm by heat applied to a fire detector on the mock-up. He will use a tester or voltohmmeter to locate a malfunction introduced into the mock-up circuit and correct the malfunction.

- Standard:
  At least two written descriptions will be correct in accordance with information provided, the circuit on the mock-up will be accurately traced, the alarm will operate, and the malfunction will be located and corrected to return-to-service standards.

Key Points	*Feedback*
Types of fire detectors.	• What causes the contacts to close when a Fenwal, Wilcolator or other thermal-switch type fire detector is subjected to heat or flame?
a. Bimetallic thermal switch types.	• What is provided to compensate for variations in air temperature around a thermal-switch type fire detector?

	•What type of electrical circuit is used with thermal-switch type fire detectors?
b. Thermocouple type.	•What is the principle of operation of a thermocouple type detector such as the Edison fire detector? •How is compensation for ambient temperature variations provided for thermocouple type fire detectors? •What type of electrical circuit is used with thermocouple fire detectors? •Why must correct polarity be observed at thermocouple fire detector connections?
c. Continuous loop type.	•Name at least two types of continuous loop fire detectors. •Will a resistance loop be operative if broken? •Will a Lindburg loop be operative if broken? •Can loop type fire detectors be repaired if broken?
Checking fire detectors and fire detection systems.	•How can loop type fire detectors be checked for being operative? •Why is some cockpit test for checking operation of fire detection a necessity? •How can a switch type fire detector be checked for being operative by use of a voltohmmeter and heat? •What checks can be made for operation of a thermocouple type fire detector by use of a voltohmmeter and heat? •Why is a visual inspection the first thing to be done when checking for trouble in a continuous loop fire detector?

Activities	*Check Items*
	Did the student:
Trace a fire detector circuit on a mock-up of a fire detection system.	•Note the aircraft location for each component of the fire detection system?
Describe how the detector provides a signal, how the signal is used to sound an alarm and light a red warning lamp and how a test signal can be initiated to check the operation of the system.	•Use proper terminology when describing the various parts of the system? •Make sure electrical power is on, for operation of the relays, alarm, and warning lamps? •Operate the test circuit to assure the mock-up system is operative?
Activate the alarm by holding a flame or heat near a fire detector in the mock-up system.	•Keep heat applied to one detector for sufficient time to allow for any time delay built into the system?
Check the system with a tester or voltohmmeter, locate and correct a malfunction introduced by the instructor.	•Use the tester or voltohmmeter properly for the type of fire detectors being checked?

SELECT AND OPERATE FIRE EXTINGUISHERS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
Written information or manufacturer's manuals, water and CO^2 or dry powder fire extinguishers, samples of fire extinguishing agents, provisions for safely conducting fire extinguishment and materials for class A and B fires, and questions with multiple choice answers, and excerpts from national or local fire safety regulations.

- Performance:
The student will select answers to ten questions dealing with proper type of fire extinguisher or extinguishment material to use for extinguishing class A, B, and C fires and the kinds of fires included in each classification. He will select proper type of extinguisher and extinguish one trash or wood fire and one fuel fire. He will select answers to ten questions dealing with hazards and precautions in handling fire extinguishers, in fighting electrical fires and when using certain types of fire extinguishers in closed or poorly ventilated areas, and the characteristics of gasoline and kerosene fires and their extinguishment.

- Standard:
Select at least eight correct answers for each set of ten questions, and one correct type of extinguisher each for class A and B fires. He will handle fire extinguisher and extinguish fires in accordance with safety regulations provided.

Key Points	*Feedback*
Classes of fires and types of extinguishers suited for each class.	• Name the three classes of fires and the types of materials associated with each.
a. Class A fires.	• Where would class A fires be likely to be encountered in aircraft? In parking and work areas? • What types of extinguishing agents are most likely to be available to fight class A fires? • What type of extinguisher is most commonly provided in aircraft for class A fires?
b. Class B fires.	• What types of class B fires are likely to be encountered around aircraft? In work hangers? • Which types of extinguishers are best suited for fighting fuel and oil fires? • What kinds of extinguishment agents are used in portable fire extinguishers around aircraft work and loading areas?
c. Class C fires.	• What types of extinguishers and extinguishing agents should be avoided in fighting class C fires? Why? • Which types of portable extinguishers are most suitable for electrical fires?
Handling of portable extinguishers.	• How close to a fire should a person get before initiating discharge of a portable extinguisher? • How can the extinguishing agent be used as a protective curtain for the operator? • What precautions should be taken when fighting a wheel fire caused by hot brakes? • Why should all of the hose be unreeled before releasing pressure when using extinguishers with extended hoses?
Fuel and oil fires.	• Where does ignition start in a gasoline fire? In a kerosene fire? • Why are flashbacks to be expected when fighting fuel fires? How can they be avoided? • Why is a fuel fire much more difficult to extinguish after it has burned a short while?

Activities	*Check Items*
	Did the student:
Select proper extinguishers for class A and B fires and extinguish one trash or wood fire and one fuel fire.	• Select a water type extinguisher for the trash or wood fire? • Select a CO^2 or dry powder extinguisher for the fuel fire? • Use both extinguishers in a safe and effective manner?

CHECK, TROUBLESHOOT AND REPAIR AIRCRAFT BUILT-IN FIRE EXTINGUISHING SYSTEMS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  Manufacturer's or equivalent information, an aircraft or mock-up with a built-in aircraft fire extinguishing system which is electrically controlled, suitable test equipment and tools.

- Performance:
  The student will draw a block diagram of the built-in fire extinguishing system, label each major component showing unit name, location in aircraft and function. He will draw a simplified diagram of the electrical control circuit identifying components and listing function of each component. He will check continuity of the electrical circuit, check the pressure of the fire extinguishing agent in the container and list three possible causes for system failure to operate.

- Standard:
  At least 70 percent of the components will be correctly identified, properly located, and correct function shown. The electrical control circuit will be accurate in accordance with information provided. Container pressure and continuity check of the circuit will be done in accordance with procedures provided and at least two possible causes of system failure will be correctly listed.

Key Points	*Feedback*	*Activities*	*Check Items* Did the student:
Aircraft built-in fire extinguisher systems.	•Name several fire extinguishing agents which have been used in aircraft fire extinguishing systems. •Why has freon been favored for most large modern aircraft systems? •Why are dual bottles used in most aircraft systems? •What methods are used to mechanically and electrically discharge the containers?	Draw a block diagram of a built-in electrically controlled aircraft fire extinguishing system which is on an available aircraft or mock-up. Draw a simplified schematic of the electrical control circuit for the fire extinguishing system, labeling components, and listing function of each component. Check the pressure in a built-in fire extinguisher container. Check continuity of the electrical circuit. List three possible causes for system failure of the built-in fire extinguishing system.	•Identify each component by name, location in the aircraft and function in the system? •Show source of electrical power? •Show how the system is armed or activated? •Show how discharge is electrically initiated and how this results in release of the fire extinguishing agent? •Show thermal and normal discharge discs and their functions? •Properly use electrical continuity test equipment? •Include previous accidental or thermal discharge as a possible cause for system failure?
Pressure and discharge indication.	•How can the pressure be checked for each container? •What indicators are provided to show that normal or thermal discharge has taken place? •What is provided in the cockpit to show which system is ready for discharge when the system has been armed?		
Malfunctions and troubleshooting.	•What could cause the failure of one bottle to discharge when called for? •What could cause failure of the entire system to operate? •What could cause a bottle to discharge into other than the selected area? Into more than one area?		

CHAPTER III

POWERPLANT CURRICULUM INSTRUCTIONAL UNITS

There are two sections included in the Powerplant Curriculum: Powerplant Theory and Maintenance and Powerplant Systems and Components. The instructional units in the Powerplant Curriculum, combined with the General Curriculum, will provide a student with the necessary technical knowledge and manipulative skills to become a licensed powerplant mechanic.

Although a sequence for instruction is presented in this report, the instructional units may be rearranged to better accommodate a particular school's requirements. As in the case of the General and Airframe Curriculums, the segments under each of the instructional units should remain with the unit if maximum instructional impact is to be achieved.

The total time alloted for this section by FAR 147 is 750 hours. The Powerplant Curriculum as shown in this publication provides for 740 hours of instruction. The remaining ten hours may be used for review, additional practice, and/or examinations.

Preceding both the Powerplant Theory and Maintenance and the Powerplant Systems and Components instructional units is an outline of the instructional units and their segments for each particular subdivision. The estimated time allotment is also provided; this may be adjusted to meet the requirements of each particular school. As with the General and Airframe Curriculums, an adjustment of time for each instructional unit is permissible as long as it does not jeopardize a student's learning attainment of the other instructional units as specified in FAR 147.

In this Curriculum, as well as in the General and Airframe Curriculums, projects must be representative of the aviation industry and time allotments for practice on level 3 projects must be appropriate and of sufficient duration. Furthermore, there should be a minimum time lag between theory classes and laboratory/shop instruction.

Instructional space should be adequate to handle the projects and to safely accommodate the number of students involved in instructional activities. Space must be provided for the disassembly, repair, cleaning, inspecting, assembly, testing, and servicing of engines, engine components, and accessories. Facilities for running engines with the containment of noise to adjacent areas is important for the elimination of instructional interruption in other areas of the school. Each of the instructional areas should have accessible storage which protects parts from damage and at the same time permits easy retrieval.

Projects should be of the type and quantity which allow each student to receive an identical instructional experience. Worn fasteners should not be used on level 3 projects if students are to develop level 3 skills. As with other curriculum areas, instructional activities should be related to the student performance goals for each of the segments. If a school cannot provide the items and/or conditions identified by a student performance goal, then it should either obtain the necessary materials and projects or rewrite the student performance goal so that it better relates to the materials and projects unique to the school. It is extremely important that the student performance goal should be directly related to the instructional activities if the student is to receive maximum instructional benefit.

OUTLINE POWERPLANT CURRICULUM – PART I, POWERPLANT THEORY AND MAINTENANCE

Instructional Units, Segments, and Estimated Instructional Time

RECIPROCATING ENGINES

1. OVERHAUL RECIPROCATING ENGINES.	- Level 2	104.0 hrs.
A. Explain the principles of the Otto cycle.	- Level 2	
B. Use correct cylinder nomenclature.	- Level 2	
C. Identify crankshaft and rod assemblies.	- Level 2	
D. Recognize and classify types of reciprocating engines.	- Level 1	
E. Recognize and describe propeller reduction systems.	- Level 2	
F. Identify nose and power cases and describe loads.	- Level 1	
G. Recognize, identify and describe function of valve springs.	- Level 1	
H. Identify factors affecting volumetric efficiency.	- Level 1	
I. Timing valves and explaining valve overlap.	- Level 2	
J. Identify, clean and inspect various types of bearings.	- Level 2	
K. Determine firing order of reciprocating aircraft engines.	- Level 2	
L. Determine direction of rotation and speed of engine accessory drives.	- Level 2	
M. Identify and describe problems associated with high power operation.	- Level 1	
N. Preparation of a work station for overhaul of an engine.	- Level 2	
O. Overhaul reciprocating engine	- Level 2	
2. INSPECT AND REPAIR RECIPROCATING ENGINES.	- Level 2	43.5 hrs.
A. Inspect a cylinder.	- Level 2	
B. Detect defects in crankcase assemblies.	- Level 2	
C. Remove and replace a stud.	- Level 2	
D. Select serviceable bearings.	- Level 2	
E. Dimensionally inspect a crankshaft.	- Level 2	
F. Identify, remove and reinstall piston and knuckle pin retainers.	- Level 2	
G. Identify, dimensionally inspect various cams and cam-followers.	- Level 2	
H. Inspect, reface and reseat valves in a cylinder.	- Level 2	
I. Install cylinder assembly on an engine.	- Level 2	

3. INSPECT, CHECK, SERVICE AND REPAIR OPPOSED AND RADIAL ENGINES AND RECIPROCATING ENGINE INSTALLATIONS. - Level 3 51.0 hrs.
   - A. Check and rig cable operated and push-pull engine controls. - Level 3
   - B. Recognize and identify dynamic engine mounts. - Level 1
   - C. Recognize unbalance and "critical vibration range" of propellers. - Level 2
   - D. Operate an engine at various power settings. - Level 3
   - E. Adjust oil pressure. - Level 3
   - F. Check operation of an oil dilution system. - Level 3
   - G. Perform an ignition check on an operating engine. - Level 3
   - H. Install and time a magneto to an engine. - Level 3
   - I. Adjust idle speed and mixture on a carbureted engine. - Level 3
   - J. Perform a compression check of an engine. - Level 2
   - K. Adjust valve clearances and make valve timing checks. - Level 3
   - L. Identify the probable source of metal particles found in oil screens. - Level 2

4. INSTALL, TROUBLESHOOT, AND REMOVE RECIPROCATING ENGINES. - Level 3 40.0 hrs.
   - A. Lift or hoist an engine into an engine mount. - Level 3
   - B. Install and remove a propeller from the propeller shaft. - Level 3
   - C. Pre-oiling of overhauled engines. - Level 2
   - D. Remove and reinstall baffles. - Level 2
   - E. Demonstrate correct engine starting procedures. - Level 3
   - F. Recognize symptoms that indicate operational distress. - Level 2
   - G. Operate an engine equipped with a constant speed propeller and/or supercharger. - Level 2

Estimated Instructional Time . . . . . 233.5 hrs.

TURBINE ENGINES

5. OVERHAUL TURBINE ENGINES. - Level 2 34.0 hrs.
   - A. Illustrate Newton's laws and the Brayton cycle. - Level 2
   - B. Explain relationship of RPM and thrust in a turbine engine. - Level 2
   - C. Identify and explain the characteristics of different turbine compressors. - Level 2
   - D. Identify major components and explain airflow in fan or by-pass turbine engines. - Level 2
   - E. Identify pressure changes in a turbine engine. - Level 2

F.	Identify airflow in diffusers.	- Level 2	
G.	Identify types and characteristics of combustion chambers.	- Level 2	
H.	Identify impulse and reaction blades and thrust reversers.	- Level 2	
I.	Compare characteristics of turboprop and reciprocating engines.	- Level 1	
J.	Overhaul turbine engine.	- Level 2	
K.	Describe modular overhaul.	- Level 1	
6.	INSPECT, CHECK, SERVICE, AND REPAIR TURBINE ENGINE INSTALLATIONS.	- Level 2	10.0 hrs.
A.	Remove and install a combustion case and liner.	- Level 2	
B.	Disassemble and reassemble compressor section of a turbine engine.	- Level 2	
C.	Remove and reinstall a fuel nozzle in a turbine engine.	- Level 2	
7.	INSTALL, TROUBLESHOOT, AND REMOVE TURBINE ENGINES.	- Level 2	10.5 hrs.
A.	Identify damaged turbine blades.	- Level 1	
B.	Recognize and identify combustion chamber hot spots.	- Level 2	
C.	Adjust fuel control of a turbine engine.	- Level 2	
D.	Recognize the effects of exhaust nozzle area.	- Level 1	
E.	Identify compressor surge.	- Level 1	
F.	Identify causes for performance loss	- Level 1	
G.	Removal and installation of turbine engine.	- Level 1	
		Estimated Instructional Time	54.5 hrs.

ENGINE INSPECTION

8.	PERFORM POWERPLANT CONFORMITY AND AIRWORTHINESS INSPECTION.	- Level 3	10.0 hrs.
A.	Inspect an engine for compliance with airworthiness directives.	- Level 3	
B.	Inspect an engine for conformity with specifications.	- Level 3	
		Estimated Instructional Time	10.0 hrs.
		Total Estimated Instructional Time	303.0 hrs.

RECIPROCATING ENGINES

1. OVERHAUL RECIPROCATING ENGINES.

(EIT = 104 hrs., T = 24 hrs., L/S = 80 hrs.)
15 segments

(UNIT LEVEL 2)

EXPLAIN THE PRINCIPLES OF THE OTTO CYCLE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Unlabeled sketches or diagrams illustrating the five events and four strokes of an Otto cycle.
- **Performance:**
  The student will label the illustrations and describe the five events which occur in an Otto cycle.
- **Standard:**
  The labeled sketches or diagrams will correctly identify piston, valve, and crankshaft positions in each of the four strokes. Correct nomenclature will be used in labeling the diagrams and while describing the events.

Key Points	*Feedback*
Engine cycles.	•What is the difference between a 2–stroke and a 4–stroke engine? •What is an engine stroke? •What is meant by TDC and BDC? •How is the position of the crank throw related to the position of the piston?
Events in the engine cycle.	•What is the sequence of events for an Otto cycle engine? A two-cycle engine? •What is the position of an intake valve during the last portion of the exhaust stroke? •Why are valves timed in relation to the crankshaft rather than position of the piston? •During which event are both of the valves closed? •What principle causes air to flow into the cylinder during the intake stroke?

Activities	*Check Items* Did the student:
Label the sketch or line drawing identifying each of the four strokes.	•Correctly label the diagram? •Use correct nomenclature during the explanation?
Illustrate the valve positions during each of the events of the Otto cycle.	
Describe the sequence of events in an Otto cycle.	•Use correct sequence?

USE CORRECT CYLINDER NOMENCLATURE.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  A typical air cooled cylinder, an unlabeled diagram or sketch of that cylinder, and appropriate reference manuals.
- **Performance:**
  The student will interpret information from the manual, identifying the construction features of the cylinder and label the diagram or sketch.
- **Standard:**
  The student will identify as a minimum requirement, the following parts of the cylinder: barrel, head, skirt, fins, base flange, rocker cover, valve guide and seats, valve ports, spark plug bushings. Correct nomenclature will be used when labeling the diagram or sketch.

Key Points	*Feedback*
Nomenclature of a cylinder.	•Why does the exhaust valve area of the cylinder have more fins than the intake port area? •How are cylinder heads attached to the cylinder barrel? •Why is the aluminum head of the cylinder not used as a guide and seat for the valves?
Materials used in cylinders.	•What materials are used in the production of cylinder heads?

	• From what materials are cylinder barrels and liners made? • What materials are used for valve seats? Valve guides?

Activities	*Check Items*
	Did the student:
Label the sketch or diagram identifying: a. Cylinder barrel. b. Cylinder head. c. Cylinder skirt. d. Fins. e. Base flange. f. Rocker cover. g. Valve guide. h. Valve seat. i. Valve port. j. Spark plug bushings.	• Exercise care while examining and handling the cylinder? • Use correct nomenclature and correctly label the drawing or sketch?

IDENTIFY CRANKSHAFT AND ROD ASSEMBLIES.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  A display of various crankshaft and rod assemblies and associated reference manuals.

- **Performance:**
  The student will examine the crankshaft and rod assemblies and identify an assembly from an engine that incorporates a dynamic dampener. He will explain the purpose of a dynamic dampener. The student will identify, disassemble and reassemble an articulating rod in a master rod assembly, naming and describing the function of the principal parts of the crankshaft assembly.

- **Standard:**
  The student will correctly distinguish between the various types of crankshafts and rod assemblies. He will follow the correct procedure while disassembling and reassembling the articulating rod and will accomplish the assignment without damage to the tools or part of the engine. Correct nomenclature will be used during all explanations.

Key Points	*Feedback*
Identification of types of crankshafts and rod assemblies.	• What is the purpose of a crankshaft? • What is the difference between a counterweight and a dynamic dampener? • What are the principle types of crankshaft assemblies? • What are the principle types of rod assemblies? • What is the difference between a master and an articulating rod? • What methods are generally used to secure the position of the knuckle pins in the master rod? • What are some of the precautions to be observed in the inspection and handling of crankshafts and rod assemblies? • What process may be applied to the main bearing journals to reduce wear? • Why are sludge tubes and plugs incorporated in the design of a crankshaft?
Materials used in the crank and rod assemblies.	• What are the principle materials used in the construction of crankshafts?

Activities	*Check Items*
	Did the student:
Name and identify the parts of a crankshaft and rod assembly. Describe function.	• Protect the parts from damage while they were being handled? • Use correct nomenclature? • Correctly describe the function of a crankshaft and rod assembly?
Disassemble and reassemble an articulating rod of a master rod assembly.	• Follow procedures detailed in the manual? • Select and use correct tools? • Practice safety when handling tools and engine components?

RECOGNIZE AND CLASSIFY TYPES OF RECIPROCATING ENGINES.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- **Given:**
  A random display of air or liquid cooled engines of the radial, opposed and in-line cylinder arrangement.

- **Performance:**
The student will physically examine the engines and classify them by both cylinder arrangement and method of cooling.

- **Standard:**
Identification will be without error.

Key Points	*Feedback*
Cooling methods.	• What are some of the advantages of air cooling over liquid cooling for aircraft engines? • What are some of the disadvantages of air cooled engines? • How does the cooling of an engine influence the fits and clearances that will be required between parts within the engine? • What effect does oil viscosity have on cooling and engine wear?
Cylinder arrangements.	• Why must a single row radial engine have an odd-number of cylinders? • What would be the cylinder arrangement of a 14 or 18 cylinder radial engine? • Why are in-line and opposed engines designed with an even number of cylinders?

RECOGNIZE AND DESCRIBE PROPELLER REDUCTION SYSTEMS.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- **Given:**
A drawing or sketch of both a spur and a planetary propeller reduction gearing including BMEP systems, and a display or cutaway of one of the two systems.

- **Performance:**
The student will label the components illustrated in the drawing. He will indicate by means of arrows the direction of rotation of each of the gears in the reduction system and describe three reasons for reducing propeller speeds. He will trace and explain the operation of the BMEP system.

- **Standard:**
Correct nomenclature will be used in labeling the drawings and describing the systems.

Key Points	*Feedback*
Propeller speed reduction.	• What factors limit the rotational speed of a propeller? • Why are higher rotational speeds beneficial to the power available from a piston engine? • How would the use of a larger diameter propeller affect propeller RPM?
Types of gear reduction.	• Why is it necessary to have a stationary gear (sun) in a planetary system? • What are some of the advantages of a spur gear system over a planetary system? • Does disassembly of a spur gear propeller reduction system constitute a major repair of the engine? • Explain why the direction of rotation of the propeller shaft is influenced by the type of gear reduction provided to the engine.

Activities	*Check Items*
	Did the student:
Label the component parts illustrated in the drawing. Indicate direction of gear and shaft rotation. Explain the purpose and function of a propeller reduction system.	• Use correct nomenclature in labeling the drawing and explaining the system? • Correctly illustrate direction of rotation?

IDENTIFY NOSE AND POWER CASES AND DESCRIBE LOADS.

(SEGMENT F, LEVEL 1)

Student Performance Goal

- **Given:**
Mock-ups, cutaways or actual nose and power cases of reciprocating engines.

- **Performance:**
The student will recognize the construction features and describe how the working loads are imposed on the nose and power cases.

- **Standard:**
The student will use correct nomenclature to identify the features and describe the loads and forces.

Key Points	*Feedback*
Power case loads.	•What forces act on the power case of a reciprocating engine? •Describe two of the methods that are used to attach the cylinder hold down flanges to the power case. •Why aren't gaskets and sealing compounds normally used between the cylinder flanges and the power cases? •What are the advantages of thru-bolts over studs in main power cases?
Nose case loads.	•How are thrust loads transmitted to the nose case? •How are gyroscopic forces developed in an engine? •How are torque loads absorbed in the nose case of an engine? •How are radial loads imposed on the nose case transmitted to the power case?
Construction features.	•How is the thrust bearing retained in the nose case? •What design feature of a nose case provides a ready identification of a propeller reduction system?

RECOGNIZE, IDENTIFY AND DESCRIBE FUNCTION OF VALVE SPRINGS.

(SEGMENT G, LEVEL 1)

Student Performance Goal

- **Given:**
A random display of poppet valve spring assemblies from typical aircraft piston engines.

- **Performance:**
The student will recognize and identify a multi-spring assembly from the valve spring display and describe the reasons for the use of multi-springs in aircraft engines.

- **Standard:**
Recognition and identification of the assembly will be without error. The student will cite at least two reasons for the use of multi-spring assemblies.

Key Points	*Feedback*
Purpose of multi-springs.	•In what way does the use of multi-springs provide a safety factor? •Explain why valves may tend to "float" or "bounce" at high speeds. •Why does the inner valve spring often coil in a direction opposite the direction of the outer spring? •What physical characteristics of one spring will tend to damp the frequency of vibration of a second spring? •What tools and procedures are necessary to check a spring for tension? Compression? •Why does a multi-spring usually rest on a washer instead of bearing directly upon the cylinder head?

IDENTIFY FACTORS AFFECTING VOLUMETRIC EFFICIENCY.

(SEGMENT H, LEVEL 1)

Student Performance Goal

- **Given:**
Information sheets, reference manuals and a listing of at least seven factors that affect the volumetric efficiency of an engine.

- **Performance:**
The student will explain how five of the factors are related to volumetric efficiency.

- **Standard:**
Correct nomenclature will be used with at least five factors of the explanation.

Key Points	*Feedback*
Volumetric efficiency.	•How does the surface roughness and shape of an intake manifold affect volumetric efficiency? •What is meant if an engine is described as "normally aspirated"?

- What is the effect of supercharging on the volumetric efficiency of an engine?
- How would a leak in an intake manifold affect volumetric efficiency?
- How does the compression ratio of an engine affect volumetric efficiency?
- How does the maximum RPM of an engine relate to volumetric efficiency?
- How does valve timing affect volumetric efficiency?
- Explain how throttle position is related to volumetric efficiency?
- How does the propeller load relate to the volumetric efficiency of the engine?

TIMING VALVES AND EXPLAINING VALVE OVERLAP.

(SEGMENT I, LEVEL 2)

Student Performance Goal

- **Given:**
  A valve timing diagram and a blank table of limits chart with manufacturer's instructions for an engine that incorporates external valve timing adjustments.

- **Performance:**
  The student will describe the purpose of valve overlap and explain how valve overlap affects engine performance. Provided with the manufacturer's manuals, the student will interpret the instructions, complete the diagram, and table of limits chart for timing the valves of the engine.

- **Standard:**
  The student will use correct nomenclature as part of the descriptions and explanations. Valve timing diagram and completed table of limits will be within the tolerance prescribed in the manufacturer's manual.

Key Points	*Feedback*
Valve timing.	• Why must a mechanic be thoroughly familiar with the abbreviations "BDC, TDC, After BC, Before TC" etc.? • Why is it important that valves be "timed"? • What is meant by "lead and lag"? • What is the effect of excessive hot clearance when making a valve timing check? • What is meant by the "cold" clearance of a valve? • What is a valve overlap?
Nomenclature of valve gear trains.	• What is a cam ring or cam plate? • What is a cam shaft? • What is a cam lobe? • What is a cam follower? • What is the purpose of a ramp on a cam lobe? • What is a "zero lash" valve lifter? • How are rocker arms lubricated?
Using timing diagrams.	• Why is the opening and closing of a valve diagrammed in terms of crankshaft rotation rather than piston position? • Why does the timing of valves on a radial engine require adjusting of valve clearances, and opposed engines equipped with hydraulic lifters do not require such adjustments?

Activities	*Check Items*
	Did the student:
Draw Diagram.	• Use correct nomenclature as part of the explanation? • Accurately complete diagram?
Complete table of limits.	• Correctly interpret the instructions and follow the recommended procedures? • Accurately comple table of limits?

IDENTIFY, CLEAN AND INSPECT VARIOUS TYPES OF BEARINGS.

(SEGMENT J, LEVEL 2)

Student Performance Goal

- **Given:**
  A random display of plain, roller, ball and needle bearings of the types found in aircraft engines and the manufacturer's manuals specifying the inspection procedures and limits applicable to these bearings.

- **Performance:**
From this display of bearings, the student will name and identify each type of bearing and describe one probable location where such bearing would be used within the engine. He will clean, inspect each type of bearing and judge whether the bearing is of return-to-service quality.

- **Standard:**
Identification of each type of bearing will be without error. Interpretation of the tolerance and procedures specified in the manuals and the acceptance or rejection of the bearings will be accurate.

Key Points	*Feedback*
Types of bearings.	• What type of bearing is designed to accept thrust loads? • What kinds of bearings are used to carry heavy radial loads? • What type of bearing is used under high rotational speeds?
Lubrication of bearings.	• How are plain type bearings lubricated? i.e., by spray, by splash or by pressure? • How are roller bearings generally lubricated?
Storage, handling of bearings.	• How should a mechanic prepare a new, sealed ball bearing for installation? • How should a mechanic prepare a servicable bearing for long term storage? • How are bearings cleaned prior to inspection?
Inspection and installation.	• How is the thrust direction of a ball bearing determined? • What installation procedure will insure the minimum damage to the seal of a sealed ball bearing?

Activities	*Check Items*
	Did the student:
Visually and dimensionally inspect plain, ball, roller and needle bearings.	• Follow the procedures specified in the manual? • Inspect and correctly judge the servicability of the bearings?
Clean, lubricate bearing and prepare for storage.	• Carefully handle bearings to avoid damage?

DETERMINE FIRING ORDER OF RECIPROCATING AIRCRAFT ENGINES.

(SEGMENT K, LEVEL 2)

Student Performance Goal

- **Given:**
Aircraft engines of the radial, opposed and inline types and the associated maintenance manuals.

- **Performance:**
The student will explain the principles that determine the firing order for each engine. Using the information available in the manuals or on the engine data plate, the student will rotate the crankshaft, observe the valve rocker arm action and point to each cylinder in the order in which it will fire.

- **Standard:**
The explanations and determination of firing order will be without error.

Key Points	*Feedback*
Firing order for:	• Why does a single row radial engine have an uneven number of cylinders?
a. Radial engines, single and twin row.	• Why does a twin row radial engine fire alternately in front and rear row?
b. Opposed engines.	• What one feature of an inline engine dictates the firing order of that engine?
c. Inline engines.	• Explain why two different firing orders may be used on four cylinder opposed engines. • How could a mechanic determine the firing order of an engine if the data plate and manual were not available?

Activities	*Check Items*
	Did the student:
Rotate crankshaft and point to each cylinder in the firing	• Correctly interpret information from the manual or data plate? • Use correct nomenclature as part of the explanation? • Verify the firing order sequence by identifying valve action and compression within the cylinder?

DETERMINE DIRECTION OF ROTATION AND SPEED OF ENGINE ACCESSORY DRIVES.

(SEGMENT L, LEVEL 2)

Student Performance Goal

- **Given:**
  Any aircraft engine incorporating at least five accessory drives, a line drawing of the accessory case of the engine and the associated manufacturer's manual.

- **Performance:**
  The student will interpret information from the manual, rotate the crankshaft of the engine, then draw arrows on the diagram illustrating the direction and the speed of accessory drive gears.

- **Standard:**
  Interpretation of information will be without error.

Key Points	*Feedback*
Location of accessory drives: a. Rear case. b. Front and intermediate cases.	• Why are some accessories mounted in front of the cylinders on a radial engine? • Why does the engine manufacturer consider the power that will be required to drive an accessory? • How is the thrust of beveled gears in a drive chain absorbed?
Direction of drive.	• If a direct spur gear is driving another gear, what will be the direction of the driven gear? • In a planetary gear system, what is the direction of rotation of the planetary gears?
Speed of rotation.	• If a gear of greater diameter is driving a gear of smaller diameter, what will be the relative speed of the smaller gear? • If the sun gear of a planetary system is not locked in position, what is the action of the other gears in the system?

Activities	*Check Items*
	Did the student:
Rotate engine crankshaft.	• Rotate crankshaft in proper direction?
Label the line drawing to indicate direction of rotation and speed of the acessory drives.	• Correctly interpret information from the service manual and correctly label the drawing?

IDENTIFY AND DESCRIBE PROBLEMS ASSOCIATED WITH HIGH POWER OPERATION.

(SEGMENT M, LEVEL 1)

Student Performance Goal

- **Given:**
  A written list describing twenty problems that are common to the operation of aircraft engines and the operation/limitations for a specific engine.

- **Performance:**
  Provided with a list describing problems common to the operation of aircraft engines, the student will identify five problems which could have resulted from high power operation before the oil temperature and pressures reached operating limits.

- **Standard:**
  At least four of the five problems identified by the student will be correct.

Key Points	*Feedback*
Operating limits.	• If a bearing within an engine is operated with insufficient lubrication, what is the most probable result? • What will be the effect if there is insufficient oil flow to the accessories of an engine? • How does temperature affect the viscosity and flow characteristics of oil and bearing clearances? • What effect does high power settings have on the loads applied to the bearings of an engine? • How can operating temperatures effect the valve timing of radial engines? • How can inadequate warm-up affect the control and response of a constant speed hydromatic propeller?

PREPARATION OF A WORK STATION FOR OVERHAUL OF AN ENGINE.

(SEGMENT N, LEVEL 2)

Student Performance Goal

- **Given:**
  A written list that identifies twenty safe and unsafe practices (normally associated with handling of engines and the preparation of a work station prior to engine overhaul), an engine and a work station.

- **Performance:**
  The student will recognize all hazardous conditions and arrange the engine in the work station for an engine overhaul.

- **Standard:**
  All hazardous practices will be identified. The sequence of operations to prepare the work station will be in general agreement with common industry practice.

Key Points	*Feedback*
Preparing a work station for overhauling an engine.	• Where would a mechanic locate information that described the kind of overhaul stand that would be necessary to overhaul a large radial engine? • What types of overhaul stands may be used when overhauling opposed engines? • What hazards are associated with the condition of the floor in the engine overhaul areas? • What considerations should be given to possible contamination from dust, sand, and dirt in the overhaul area? • What hazards are associated with the condition of parts and/or storage racks that will be used to hold the disassembled engine?
Preparing an engine for overhaul.	• Describe some of the processes that are used to clean an engine before disassembly? • What are some of the methods that may be used to record the locations of fittings and baffles? • What precautions should be observed when hoisting or lifting an engine? • Describe a method that would assist in identifying and retaining special fittings that are removed from an engine. • What procedure should be followed to install an engine in a shipping container? • Describe a procedure that should be followed to install an engine in an overhaul stand. • Why should the oil be drained and the oil screen checked before an engine is disassembled for overhaul?

Activities	*Check Items* Did the student:
Prepare work station and position an engine in the overhaul stand.	• Plan the sequence of operations? • Observe safety practices? • Maintain cleanliness and order in the work area?

OVERHAUL A RECIPROCATING ENGINE.

(SEGMENT O, LEVEL 2)

Student Performance Goal:

- **Given:**
  A small opposed or radial engine, a work station having an engine overhaul stand and necessary tables and parts racks, necessary hand and specialized tools and fixtures, an overhaul manual and overhaul inspection sheets.

- **Performance:**
  With the use of the overhaul manual the student will disassemble the engine, label and store the parts, clean the parts, inspect the parts physically, visually, and with non-destructive testing; measure the parts for wear and identify those parts that are reusable from the table of limits; reassemble the engine; and record all findings and recommendations on the overhaul inspection sheets.

- **Standard:**

All procedures followed, recorded data on the overhaul inspection sheets, and recommendations for parts rejection will be correct for the particular engine and the engine will be assembled mechanically correct.

Key Points	*Feedback*
Engine overhaul equipment.	**•What types of hand tools are required for engine overhaul?** **•What types of power equipment and presses are required for engine overhaul?** **•What are the advantages of a cradle-type overhaul stand?** **•How can an engine shipping box be used as an engine overhaul stand?** **•How are special overhaul tools obtained?**
Engine disassembly.	**•How is engine disassembly procedural sequence determined?** **•What techniques can be employed in loosening frozen fasteners?** **•How are various internal parts of the engine protected during disassembly?** **•How are parting surfaces having gaskets or "O" rings separated without damage?** **•How are scuffs and scratches prevented?**
Storing parts during overhaul.	**•How should the various parts of the engine be stored?** **•What are the correct ways for labeling the various parts of the engine?** **•How should parts from different assemblies be grouped?**
Cleaning the engine.	**•What are the methods used in cleaning parts of a disassembled engine?** **•What is the difference between degreasing and decarbonizing?** **•What are the procedures used for cleaning internal passages of an engine?** **•How are dissimilar metals placed in a gunk tank?** **•How are parts protected during sand, nut, and vapor blasting?** **•How are ball and roller bearings cleaned?** **•What dangers exist from magnetism to anti-friction bearings?** **•What procedures should be used for drying bearings and how should they be wrapped to prevent the entry of dirt?**
Physical inspection procedures.	**•How are backlash, fits, and clearances inspected?** **•How are studs checked?** **•How are flaking, pitting, galling, and excessive wear or looseness of liners identified?** **•How are bushings checked for cracks, mutilation, scoring, indications of overheating, looseness, and excessive wear?** **•Describe the inspection techniques for crankcases, brackets, adapters, sumps, and cover plates, for cracks, nicks, breaks, surface smoothness, of parting surfaces, obstructions in drill passages, tightness of plugs, and mutilation of internal threads in tapped holes.** **•How are gears examined for evidence of improper tooth bearing, pitting, fatigue cracks, excessive wear and burns?** **•How are shafts examined for straightness, condition of threads and splines, smoothness of bearing journals, excessive wear and fatigue cracks?** **•How are oil pipes inspected for dents, cracks, nicks, condition of flanges, and those oil pipes that fit in a mating bracket or hole in the crankcase for looseness of fit?** **•How are rivets examined for security of anchorage?**
Non-destructive testing.	**•What are the steps in magnafluxing?**

	•How are parts prepared and inspected with Zyglo? •Where and when should Dy-Check be used? •How are magnifying glasses used in visual inspection?
Overhaul inspection sheets and table of limits.	•Who determines the limits specified in the table of limits? •What information is contained in the table of limits? •How are engine overhaul inspection forms related to the table of limits and what readings are written on the overhaul inspection sheets? •What does the term "by selection" indicate?
Inspection gauges, indicators, and devices.	•How should micrometers, inside micrometers, micrometer depth gauges, small hole gauges, and telescoping gauges be used in making measurements of engine parts? •Describe the steps in using a dial indicator. •How are "go-no-go" gauges used?
Engine repairs.	•What repairs are permissible on the various engine parts? •What techniques are employed in replacing parts requiring the use of heat and/or cold? •What precautions should be observed in replacing a part in an assembly containing a number of parts?
Engine assembly.	•What are the procedural steps in engine assembly? •How is proper torque and clearance limits attained? •What checks should be made prior to tightening the case on certain small opposed engines? •How does internal and external safety wiring and safety fasteners differ? •What precautions should be observed with engines requiring internal timing? •How are accessories installed and what precautions should be observed for external timing?
	•How is the engine prepared for storage?

Activities	*Check Items* Did the student:
Engine disassembly.	•Use proper procedures and techniques in disassembly. •Protect the parts from damage. •Label parts correctly. •Store the parts properly.
Engine cleaning.	•Protect the parts from damage. •Clean the parts and passages thoroughly.
Inspection.	•Use proper inspection techniques, materials, tools, and equipment. •Interpret the table of limits accurately. •Record findings on overhaul inspection sheets. •Use measuring tools correctly.
Repair.	•Follow manufacturer's recommended repair procedures. •Make repairs within the limits established by the manufacturer.
Engine assembly.	•Assemble the engine in proper sequence. •Make all engine securities correct. •Check all clearance and timing measurements. •Complete the assembly with an engine that was mechanically operated.

2. INSPECT AND REPAIR RECIPROCATING ENGINES. (EIT = 43½ hrs., T = 15½ hrs., L/S = 28 hrs.) 9 segments

(UNIT LEVEL 2)

INSPECT A CYLINDER.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  A cylinder from an aircraft engine, appropriate inspection tools and reference manuals.

- **Performance:**
  The student will inspect and determine the serviceability of a cylinder.

- **Standard:**

  The student will correctly judge whether the cylinder should be rejected or returned to service.

Key Points	*Feedback*
Inspection techniques.	•Describe how a cylinder would be checked for: a. Out of round. b. Taper. c. Choke. •What physical features would make it possible for a mechanic to identify a nitrided cylinder? •How can a chromed cylinder be identified? •When inspecting a cylinder bore, where should a mechanic expect to measure the greatest wear?
Limits and tolerances.	•What publications will contain the dimensional limits applicable to a cylinder?

Activities	*Check Items*
	Did the student:
Inspect and judge the serviceability of a cylinder.	•Correctly interpret the manufacturer's inspection information? •Correctly use tools and interpret the table of limits? •Correctly judge serviceability?

DETECT DEFECTS IN CRANKCASE ASSEMBLIES.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**

  A written list of probable defects, crankcases that exhibit one or more of the defects, and the necessary inspection equipment.

- **Performance:**

  Provided with a list of the probable defects, the student will clean, visually inspect and detect the defects present in the specimen crankcase assemblies.

- **Standard:**

  The student will detect all of the defects in the crankcase assemblies.

Key Points	*Feedback*
Cleaning of crankcases.	•What materials are most generally used to clean crankcases? •What characteristics of magnesium make special handling and cleaning necessary?
Inspection.	•What is Zyglo inspection? •Describe X-ray inspection. •What is Dy-check inspection? •What inspection procedure may be used to inspect the oil passages in a crankcase? •What precautions should be observed when removing plugs from the passageways in a crankcase? •Describe the difference between visual inspection and dimensional inspection of a part.

Activities	*Check Items*
	Did the student:
Clean and inspect crankcases.	•Use correct techniques to clean and inspect the crankcases? •Recognize and identify the visual defects?

REMOVE AND REPLACE A STUD.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**

  An aircraft engine component that has a damaged or broken stud and the necessary tools.

- **Performance:**

  The student will remove a damaged stud and install a replacement stud.

- Removal of the damaged stud will not cause further damage to the component. The replacement stud will maintain a class 3 thread fit.

Key Points	*Feedback*
Removal of:	•Name and describe the use of some of the tools that are used to remove studs.
a. Damaged studs.	

b. Broken studs.	•In what manner does the technique used to remove a broken stud differ from the procedure used to remove a stud that has defective threads? •How would the removal of a stud from an aluminum case differ from the procedure used on a steel or magnesium case?
Installation of studs.	•How are +.003 oversize studs identified? •How is the material from which a stud is manufactured identified? •What procedure should a mechanic follow if a special stud driving tool is not available? •What is a helicoil?

Activities	*Check Items*
	Did the student:
Remove and install a replacement stud.	•Remove the stud without further damage to the case? •Verify the condition of the threads in the case and on the replacement stud? •Maintain alignment of the stud? •Maintain correct dimensional height of the replacement stud?

SELECT SERVICEABLE BEARINGS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  A random display of bearings which may display evidence of impending failure, an applicable table of limits and tolerances and the necessary inspection tools.
- **Performance:**
  The student will identify serviceable bearings by means of visual and dimensional inspection. He will also identify failed or failing bearings within the displayed group of bearings and when given a written list indicating where these bearings are located within an engine, will describe how these bearings could be detected in an operating engine.
- **Standard:**
  The student will identify faulty bearings without error. He will use correct nomenclature as a part of the description and explanations of symptoms which would indicate impending bearing failures.

Key Points	*Feedback*
Visual inspection of bearings.	•What is the indication of acid etch in a bearing? •What is the source of the acid that etches a bearing? •How will lack of adequate lubrication affect bearing wear? •How will worn bearings in an engine affect the operating oil pressure of that engine? •How will misalignment during installation of a bearing affect bearing wear?

Activities	*Check Items*
	Did the student:
Select serviceable bearings.	•Correctly interpret limits and tolerance charts?
Identify faulty bearings.	•Recognize 100% of the unserviceable bearings?
Describe symptoms of bearing failure.	•Associate failure with how the defect could be detected in an operating engine?

DIMENSIONALLY INSPECT A CRANKSHAFT.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- **Given:**
  A crankshaft from an aircraft engine, the necessary inspection tools and reference manuals.
- **Performance:**
  The student will check crankshaft "run-out," measure rod and main bearing journals and judge whether the crankshaft meets dimensional tolerance.
- **Standard:**
  Inspection procedure and measurements will meet return-to-service quality.

Key Points	*Feedback*
Crankshaft run-out.	•How may a check of crankshaft run-out be accomplished on a completely assembled engine?
a. Flange.	

b. Shaft.	• When accomplishing a "run-out" on a crankshaft that has been removed from the engine, why is it necessary that the "V" blocks or rollers be concentric? • Why is it necessary to use "V" blocks or rollers to check the "run-out" of a crank? • How are the center mains checked for alignment? • What is the tool or gauge that is used to check alignment? • What effect does an out-of-round main journal have on the alignment check of a crankshaft?
Measurements.	• Why aren't the bearing journals measured adjacent to the bearing oil supply hole? • What are the minimum measurements that would be necessary to detect an out-of-round condition? • If a crankshaft is dimensionally satisfactory, is it automatically airworthy?

Activities	*Check Items*
	Did the student:
Make set-up and check crankshaft run-out. Measure crankshaft journals.	• Demonstrate correct procedure and tool use? • Correctly interpret limits and tolerances?

IDENTIFY, REMOVE AND REINSTALL PISTON AND KNUCKLE PIN RETAINERS.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
  Pistons, piston pins, master rods and knuckle pins with various types of pin retainers and the applicable manufacturer's manuals.

- **Performance:**
  Provided with examples of the various types of pistons and knuckle pin retainers, the student will correctly name and identify each type. He will remove and reinstall at least one type of retainer.

- **Standard:**
  Removal and reinstallation of the retainer will be in accord with the procedure specified in the manual and will be accomplished without damaging the retainer of the engine component.

Key Points	*Feedback*
Piston pin retainers.	• What is a full-floating piston pin? • Name and describe three types of piston pin retainers. • How would a mechanic determine the correct procedure for removal and reinstallation of a piston pin retainer?
Knuckle pin retainers.	• What inspections should be made to determine the serviceability of a knuckle pin retainer? • Why are some knuckle pins pre-positioned?

Activities	*Check Items*
	Did the student:
Remove, inspect and reinstall piston pin, knuckle pin and retainers.	• Follow correct procedures? • Correctly use tools? • Observe safety precautions?

IDENTIFY, DIMENSIONALLY INSPECT VARIOUS CAMS AND CAM-FOLLOWERS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- **Given:**
  A typical camshaft, cam ring, cam-followers, the precision measuring tools and appropriate reference information.

- **Performance:**
  The student will identify the components, dimensionally inspect and describe the operation of the valve mechanisms. He will disassemble, assemble and test zerolash lifters.

- **Standard:**
  Correct nomenclature will be used to identify the components and describe the operation of valve mechanisms. Measurements will be accurate but components need not be of return-to-service quality.

Key Points	*Feedback*
Valve mechanisms.	
a. Cam rings.	•What number of cam tracks may be on each cam ring or plate?
b. Cam shafts.	•What is a ramp on a cam lobe? •On opposed engines, what are the relationships of the lobes on the camshaft and the number of valves in the engine? •How does a mechanic measure the height of a cam lobe?
c. Cam-followers.	•What is zerolash valve lifter? •What parts of a zerolash lifter assembly are not interchangeable? •What effect will a flat or struck lifter have on valve operations?

Activities	*Check Items*
	Did the student:
Describe valve operation.	•Correctly interpret the reference information? •Use correct nomenclature and terminology as a part of the description of operation?
Inspect and test a zerolash valve lifter.	•Follow correct procedures and carefully handle components and inspection tools?

INSPECT, REFACE AND RESEAT VALVES IN A CYLINDER.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  An aircraft engine cylinder containing valves, valve spring assemblies, appropriate reference information and the required tools.

- Performance:
  The student will inspect the valve assemblies, then reface and reseat the valves. He will interpret the manufacturer's overhaul instructions and describe the replacement of valve guides and valve seats.

- Standard:
  The refaced and reseated valves will not leak when checked in accordance with the manufacturer's overhaul instructions.

Key Points	*Feedback*
Types of valves and valve materials.	•What special characteristics are required of aircraft exhaust valves? •What is a sodium filled valve and what are the special characteristics? •Where is stellite used in valve construction and what is the advantage to the use of this material?
Valve seats and face angle.	•What is the significance of of the angle of the valve face? •What material is used in the construction of valve seats? •How are valve seats retained in the cylinder head?
Valve guides.	•What is the general procedure to be followed in the installation of a valve guide? •How does concentricity of the valve, seat and guide affect the valve installation? •If a mechanic is installing both a valve seat and a valve guide, what is the installation sequence? •How is valve stretch measured? •What is the desired width of contact between the valve face and the valve seat?

Activities	*Check Items*
	Did the student:
Inspect the valves.	•Follow correct procedures?
Reface and reseat a valve.	•Correctly use tools? •Check valves for leakage?

INSTALL CYLINDER ASSEMBLY ON AN ENGINE.

(SEGMENT I, LEVEL 2)

Student Performance Goal

- Given:
  A piston, pin, rings, cylinder assembly, seals, gaskets, necessary tools and reference manuals.

- **Performance:**
  The student will describe the construction features of a piston, rings and cylinder assembly. He will inspect the components, fit the pins and rings to the piston and install this assembly in the cylinder and torque the cylinder to an engine.

- Standard:
  The student will use correct nomenclature and terminology as part of the description and explanation. All work will be in accord with the manufacturer's specifications.

Key Points	*Feedback*
Construction features:	**•What is a cam ground piston?**
a. Pistons.	**•Why are relatively large clearances necessary between piston and cylinder walls?** **•Describe the different shapes of piston heads.**
b. Rings.	**•What is the function of a piston ring?** **•Why are ring clearances greater on the upper rings of a piston?**
c. Ring, piston and cylinder fit.	**•Why are some rings chrome plated?** **•What precautions apply to the use of chrome rings?** **•What is side clearance of a ring?** **•What is ring end-gap?** **•What procedure is necessary to measure the side clearance of wedge-type rings?**
Use of manuals:	**•How are cylinders attached to a powercase?**
a. Procedures.	**•Why is the master rod cylinder installed first on radial engines?** **•Why is it important that the piston rings be inspected before installation of a cylinder?** **•Why should the crankcase base area be inspected before installing a cylinder?** **•Why is the cylinder piston and ring assembly lubricated before assembly?** **•What is a ring compressor?** **•How may a mechanic distinguish between a cylinder hold down stud and a capscrew?**
b. Special tools.	**•Describe some of the special combinations of tools often required for torquing of cylinder base nuts.** **•Why is a special torque and sequence of torquing often recommended on cylinder bases?**

Activities	*Check Items*
	Did the student:
Fit rings to piston.	**•Check side and end clearances of rings?** **•Follow correct procedures and correctly use tools?**
Install piston and cylinder to the engine.	**•Check clearance of piston to cylinder and piston pin to piston?**
Torque cylinder to engine.	**•Use correct nomenclature and terminology?** **•Maintain required standards?**

3. INSPECT, CHECK, SERVICE AND REPAIR OPPOSED AND RADIAL ENGINES AND RECIPROCATING ENGINE INSTALLATIONS.

(EIT = 51 hrs., T = 20½ hrs., L/S = 30½ hrs.)
12 segments

(UNIT LEVEL 3)

CHECK AND RIG CABLE OPERATED AND PUSH-PULL ENGINE CONTROLS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  An engine control system incorporating cable and push-pull operated controls and the manual applicable to the system.

- **Performance:**
  The student will inspect and operationally check the engine control system on a mock-up or in the aircraft. He will correct minor defects and/or rig the system.

- Standard:
  The correction of defects and/or rigging of the system will result in a control system which functions within the tolerances specified in the manual.

Key Points	*Feedback*
Cable operated engine controls.	• What is the intended use of the following components which may be included in the control system: a. Quadrant? b. Bellcrank? c. Turnbuckle assembly? d. Friction adjustment? e. Shackle? f. Fork or tongue and terminal? g. Pulley and pulley guard? h. Fairlead? i. Automatic tensioner? • What is the purpose of "cushion" or "springback" in the rigging of controls? • Where should cable tension be measured in a cable operated throttle system? • What would be the effects of excessive and/or insufficient cable tension? • Name some of the engine controls that may be cable operated? • What is the purpose of a friction lock in an engine control?
Push-pull engine controls.	• What are the two principal kinds of push-pull engine control systems? • What methods are used to safety the rod ends of push-pull controls? • What is a bellcrank? • What are some of the advantages of a flexible type push-pull control? • What precautions must be observed when clamping or supporting flexible push-pull controls?

Activities	*Check Items* Did the student:
Operationally check the system for correct travel and alignment. Rig controls as required or as instructed.	• Follow the procedures specified in the manual? • Observe safety precautions? • Maintain or re-establish the rigging tolerances specified? • Safety the system following adjustments?

RECOGNIZE AND IDENTIFY DYNAMIC ENGINE MOUNTS.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- **Given:**
  A display featuring the different types of engine mounting systems.

- **Performance:**
  The student will recognize the components of an engine dynamic suspension system and explain the purpose and operating principles of the system.

- **Standard:**
  The student will point to the components and use the correct name when identifying the parts of the system.

Key Points	*Feedback*
Dynamic suspension system.	• How are the torsional loads absorbed in a dynamic suspension system? • How does aging of the neoprene or rubber portions of a dynamic suspension affect engine droop? • How will aging and deterioration affect the quality of a dynamic suspension system? • What is a dynafocal mount?

RECOGNIZE UNBALANCE AND "CRITICAL VIBRATION RANGE" OF PROPELLERS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Aircraft Specification Sheets, manufacturer's publications and a list of ten conditions which might result in propeller vibration.

- **Performance:**
  The student will explain the effects of propeller unbalance on engine operation, and when provided with appropriate reference materials, will recognize the conditions of critical vibration range in a given engine propeller combination.

- **Standard:**
  The student will use correct nomenclature and phraseology when describing propeller unbalance. He will recognize critical vibration ranges as identified in the specifications without error.

Key Points	*Feedback*
Effect of propeller unbalance on engine	**•Cite five examples that may contribute to unbalance of a propeller.** **•What damage may result from an unbalanced propeller?**
Harmonic vibrations.	**•Define a "critical range" vibration.** **•Why should propeller critical ranges be avoided during engine operation?**
Range marking and placarding.	**•What provisions are made to help a pilot and mechanic avoid the "critical range"?**

Activities	*Check Items*
	Did the student:
Use the aircraft specifications to identify an example of a "critical range" vibration.	**•Use correct nomenclature and terminology?** **•Correctly interpret the specifications?**

OPERATE AN ENGINE AT VARIOUS POWER SETTINGS.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  An operable aircraft engine on an aircraft or in a test cell and the manufacturer's operation manual for that engine.
- **Performance:**
  The student will operate the engine and demonstrate how to establish take-off clumb and cruise power settings. He will describe the factors to be considered during prolonged high power operation.
- **Standard:**
  Operation of the engines will be exactly in accord with the manufacturer's recommended procedure. When provided with a list of operating conditions, i.e., various powers, etc., he will correctly identify 80 percent of the indications that would be considered critical.

Key Points	*Feedback*
Engine operating procedures.	**•Describe the procedure for starting, operating, and stopping an aircraft engine.** **•Define the various power settings, i.e., take-off, cruise, etc.** **•Why are power settings different for take-off, climb, descent, etc.?**
Compliance with recommended procedures.	**•What procedure should be followed when changing the power settings for an engine?** **•What is the relationship of power setting and engine life or "time between overhaul"?** **•What will be the effect of an excessively lean mixture during high power operation?** **•What is the effect of a rich mixture during prolonged high power output?**

Activities	*Check Items*
	Did the student:
Operate an engine to demonstrate various power settings. Identify critical operating conditions.	**•Correctly interpret the operator manual?** **•Use correct nomenclature?** **•Observe safety precautions?**

ADJUST OIL PRESSURE.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  An operable engine (mounted in a stand or on an airplane) and the manufacturer's specifications.
- **Performance:**
  The student will operate the engine and record the operating oil temperature and oil pressure. He will then interpret the manufacturer's instructions and adjust the oil pressure to conform to the specifications.
- **Standard:**
  The operating procedures described in the manual will be followed. The adjustment of pressure will result in a final adjustment within the specified tolerance.

Key Points	*Feedback*
Lubrication systems.	•What references would a mechanic use to determine the range of oil pressure and temperature that was acceptable for a particular engine?
Instrument indications.	•How are the operating ranges for oil pressure and temperature indicated on the instruments in the cockpit? •How does oil pressure and temperature affect the viscosity of oil? •Describe some of the indications that would indicate a malfunctioning lubrication system.
Oil pressure adjustments.	•What references would a mechanic use to determine the correct procedure for adjusting oil pressure on an engine?

Activities	*Check Items*
	Did the student:
Operate an engine and record operating oil pressure and temperature.	•Observe proper pre-start safety precautions? •Follow correct run-up procedures? •Correctly interpret and record instrument indications?
Adjust oil pressure.	•Follow procedures specified in the manual? •Follow correct shut-down procedures?

CHECK OPERATION OF AN OIL DILUTION SYSTEM.
(SEGMENT F, LEVEL 3)

Student Performance Goal

- Given:
An operable engine equipped with an oil dilution system written instructions and a list describing five engine malfunctions or indications that would be associated with malfunctions of an oil dilution system or low oil supply.

- Performance:
At the conclusion of an engine operational check, the student will dilute an engine oil system. He will observe the indication of normal operation and when provided with a list of conditions describing various engine malfunctions, will recognize and describe the effects of a leaking oil dilution valve, or a low oil supply in the operation of an engine. He will detect the source of oil leaks.

- Standard:
Operation of the oil dilution system will be fully in accord with the operating procedures prescribed by the manufacturer. Correct nomenclature and terminology will be used as part of the explanation of malfunctions of the oil system.

Key Points	*Feedback*
Oil dilution system: a. Purpose.	•When is oil dilution used? How frequently should the engine lubricating oil be diluted?
b. Components.	•How and where is the fuel admitted to the oil system?
c. Operation.	•What are the indications that oil dilution is taking place? •What factors determine the duration of oil dilution? •What may result if an engine is operated for an extended period of time with a leaking oil dilution valve?
Low oil supply.	•How is the quantity of oil measured in an aircraft engine? •What reference publication would specify the minimum quantity of oil required for an engine? •How will the quantity of oil affect the oil temperature? •What effect will a low oil supply have on the oil pressure?
Loss of oil through breathers.	•What effect will worn or stuck piston rings have on internal pressures in the crankcase of an engine? •What section of an engine is normally vented to atmospheric pressure?
Loss of oil through seals and gaskets, etc.	•What effect does crankcase pressure have on engine operation? •If oil is being thrown from the propeller shaft seal, what is the probable cause? •If oil is found leaking around the rocker cover, what is the probable cause of the leak?

	• If oil is leaking at the accessory case, what seals may have failed? • How are push rod housings sealed against oil leakage?

Activities	*Check Items* Did the student:
Operate an oil dilution system.	• Follow the prescribed procedure and observe safety precautions?
Describe at least two effects of leaking oil dilution valve.	• Use correct nomenclature as a part of the explanations?
Locate the source of oil leaks on an operable engine.	• Analyze to determine the probable cause and source of leak? • Use reference manuals to determine types of seals, breathers, etc. • Follow a logical procedure to detect the source of leakage?

PERFORM AN IGNITION CHECK ON AN OPERATING ENGINE.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- Given:
  An operable reciprocating engine equipped with a dual ignition system and the associated operations, instructions or procedures.

- Performance:
  The student will perform an ignition check on an operating engine and interpret the results of this check. The instructor will then introduce a fault into the ignition system which will result in a "cold" cylinder. The student will detect this cylinder condition and describe three probable causes for this condition.

- Standard:
  The operational check of the ignition system will be fully in accord with the prescribed procedures. Detection of the cold cylinder will be prompt and the explanation of three probable causes will involve use of correct terminology and nomenclature.

Key Points	*Feedback*
Ignition system checks.	
a. Magneto switch circuitry.	• When is a magneto check performed? • What check may a mechanic make to detect a "hot mag"?
b. Operation.	• What are some of the causes for mag "drop"? • How may a mechanic determine the minimum and maximum magneto drop permitted on an aircraft engine?
c. Identifying malfunctions.	• What symptom would indicate an "open" in a magneto harness during a magneto check? • What are some of the faults in the ignition system that would result in a "cold" cylinder? • When is a cold cylinder check performed? • How will a cold cylinder affect a power check? • How will a cold cylinder affect the indication of cylinder head temperature?

Activities	*Check Items* Did the student:
Perform ignition check.	• Follow the correct procedures and operationally check the system as recommended by the manufacturer.
Detect a "cold" cylinder.	• Attain operating temperatures before attempting to locate the faulty cylinder? • Identify at least three probable causes for the malfunction?

INSTALL AND TIME A MAGNETO TO AN ENGINE.

(SEGMENT H, LEVEL 3)

Student Performance Goal

- Given:
  An operable engine, a magneto and the manufacturer's manual or instructions and equipment for the installation and timing of a magneto the the engine.

- Performance:
  The student will interpret information from the manual or information sheet and install and time the magneto to the engine.

- Standard:
  The procedure will be followed without exception. The magneto installation and timing will be of return-to-service quality.

Key Points	*Feedback*
Manuals, procedures.	**•What hazard is involved in "memorizing" a magneto timing procedure?** **•Why does ignition occur in advance of top center piston travel?** **•Why is ignition timing specified in terms of crankshaft position rather than piston position?** **•In general, what preparations are necessary before installing a magneto?** **•How does a mechanic determine that the magneto is ready for installation to the engine?** **•What tools and equipment are required to install and time a magneto to an engine?** **•Why is it necessary that gear train backlash be removed when timing a magneto to an engine?** **•What safety precaution will assure that the magneto does not fire during the magneto timing procedure?**

Activities	*Check Items*
	Did the student:
Install and time a magneto to the engine.	**•Follow the procedures prescribed in the manual?** **•Properly use tools and equipment?** **•Observe safety precautions?** **•Achieve desired accuracy?**

ADJUST IDLE SPEED AND MIXTURE ON A CARBURETED ENGINE.

(SEGMENT I, LEVEL 3)

Student Performance Goal

• Given:

An operable, carbureted engine and the manufacturer's operating instructions, manuals and procedures.

• Performance:

The student will make an operational check of the engine, then adjust both idle speed and mixture to the limits and tolerances prescribed by the manufacturer.

• Standard:

The procedure specified will be followed without exception. The adjustments will result in a condition that would permit return-to-service.

Key Points	*Feedback*
Operating practices.	**•Describe the safety precautions that would be observed prior to starting an aircraft engine.** **•What procedures should be followed during engine runup?** **•What would be the position of the mixture control at the start of an operational check?** **•What are the indications of a correct idle speed and idle mixture adjustment?** **•What will be the effect of carburetor heat while the engine is operating at low idle speeds?** **•How does carburetor heat affect the mixture available to the engine?** **•What is the effect of a constant speed propeller on the procedure necessary to set idle speed and idle mixture?** **•What is the procedure and about how often must the engine be "cleared" while making an idle mixture adjustment?**

Activities	*Check Items*
	Did the student:
Operate engine and adjust idle speed and mixture.	**•Follow the operating procedures specified in the manuals?** **•Observe safety precautions?** **•Achieve acceptable results from the adjustments?**

PERFORM A COMPRESSION CHECK OF AN ENGINE.

(SEGMENT J, LEVEL 2)

Student Performance Goal

• Given:

An operable aircraft engine, a compression testing device and the operating instruction provided with the type of tester being used.

- **Performance:**

The student will perform a compression check on the engine. Provided with a written list of five symptoms associated with low compression, he will describe the probable cause and a sequence that he would follow to isolate the problem.

- **Standard:**

The procedure followed will be in accordance with the instructions provided by the manufacturer. The record of compression will reflect the cylinder conditions within the accuracy of the tester used.

Key Points	*Feedback*
Compression checks:	• What does a compression test of an engine prove?
a. Purpose	• What limits should be applied to the results of the check? • Describe two different methods of compression checking an engine. • What indications of a compression check would indicate leakage of an exhaust valve? • How may a compression check indicate blow-by of the piston rings? • Why should the results of a compression check be recorded as a written record rather than merely checked as being OK?
b. Engine operational indications of poor compression.	• What manifold pressure indications would be normal to an engine with poor compression? • Describe five symptoms that would be associated with an engine having poor compression. • What sequence would assist in determining the cause of low compression?

Activities	*Check Items*
	Did the student:
Perform compression check.	• Follow the procedures and instructions for use of the specific tester? • Observe safety precautions?
Interpret compression test readings.	• Correctly interpret test results and outline a procedure and sequence that would isolate the cause of the problem?

ADJUST VALVE CLEARANCES AND MAKE VALVE TIMING CHECKS.

(SEGMENT K, LEVEL 3)

Student Performance Goal

- **Given:**

Both radial and opposed type aircraft engines, incorporating either solid or hydraulic valve lifters, the associated manufacturers manuals and equipment.

- **Performance:**

Provided with appropriate information, the student will adjust the valve clearances and make valve timing checks on engines equipped with solid and/or hydraulic lifters. Using a chart or diagram, he will explain the relationship between hot and cold clearance and when given the number of cam lobes he will be able to compute the speed of the cam in relation to crankshaft speed. He will time the valves on a radial engine in accordance with the manufacturer's instructions and be able to explain the effects of excessive and insufficient valve clearance.

- **Standard:**

The procedures and tolerances specified in the instructions will be maintained. Explanations will involve use of correct nomenclature and terminology.

Key Points	*Feedback*
Valve mechanisms:	• Where are valve clearances measured?
a. Clearance adjustments.	• Why should valve clearances be rechecked after torquing and adjusting lock-out? • What is the primary advantage of a hydraulic valve lifter? • How is a hydraulic lifter checked for proper operation? • At what period of time is a hydraulic lifter replaced? • Why may a manufacturer specify greater clearance for the exhaust valves of an engine than the intake valve clearance? • Why does the "operating" or "hot" clearance of a valve differ from the "cold" clearance? • How does excessive valve clearance effect the valve timing of an engine?

	•How does insufficient clearance effect valve timing? •What effect will excessive or insufficient intake valve clearance have on engine operation?
b. Cam speeds.	•How could a mechanic determine the speed of the cam in an engine?

Activities	*Check Items*
	Did the student:
Check and adjust valve clearances and valve timing. Make a sketch to illustrate cam speed and direction of rotation.	•Mark the valve rocker covers to indicate positions prior to removal? •Correctly interpret manuals to establish cam and valve positions prior to checking valve clearances and timing? •Achieve required accuracy of adjustment? •Use correct nomenclature as a part of the explanations? •Compute correct speed and rotation?

IDENTIFY THE PROBABLE SOURCE OF METAL PARTICLES FOUND IN OIL SCREENS.

(SEGMENT L, LEVEL 2)

Student Performance Goal

- **Given:**
  A list naming at least five metals that may be found in the oil screens of an engine.
- **Performance:**
  From a list of metals that may be found in an oil screen during an engine inspection, the student will identify the probable part of the engine which has failed and describe the probable causes for this type of failure.
- **Standard:**
  The student will identify the names of the engine parts that contain at least three of the metals listed. He will use correct nomenclature when describing the probable causes of failure.

Key Points	*Feedback*
Metals found in oil screens.	•What causes metals to be deposited on the oil screens? •What techniques and procedure will assist in identifying the different metal particles? •How can carbon and varnish particles be identified?
Metals used in engine components.	•Name some engine parts that are normally constructed from steel, chrome, bronze, copper, silver, lead, tin, aluminum, etc.?
Quantity of metal particles.	•What constitutes a "normal" or "nominal" amount of metal in the oil screens? •If metal is found at the first oil change following overhaul, what action should be taken? •If increasing amounts of metal are detected during successive oil changes, what action is dictated?

Activities	*Check Items*
	Did the student:
Identify probable source of metal and cause.	•Use correct nomenclature as part of the explanation?

4. INSTALL, TROUBLESHOOT, AND REMOVE RECIPROCATING ENGINES. (EIT = 40 hrs., T = 15½ hrs., L/S = 24½ hrs.) 7 segments

(UNIT LEVEL 3)

LIFT OR HOIST AN ENGINE INTO AN ENGINE MOUNT.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  Necessary lifting or hoisting equipment, an aircraft engine, test stand or airplane and written instructions or procedures.
- **Performance:**
  The student will demonstrate a correct method of hoisting or lifting an engine into the shock mounts of an airplane or test stand.
- **Standard:**
  The procedure will be accomplished in strict accordance with the instructions supplied. Every safety precaution will be observed and the installation will be accomplished without damage to the engine or equipment beyond minor damage to the finish.

Key Points	*Feedback*
Hoisting and lifting methods.	**•What factors dictate the size and kind of lifting equipment that should be used to install an engine?** **•How are the lifting or hoisting points on an engine identified?** **•What is a spreader bar in an engine lifting sling?** **•How will the center of gravity of an engine be affected if the engine is removed while the propeller is still installed?**
Engine shock mounts.	**•How do shock mounts reduce the vibration effects of the engine?** **•What is the advantage of dynamic suspension?** **•How does age and deterioration affect the resiliency of a shock mount?** **•What is the normal service life of a "rubber" type shock mount?** **•How does a misaligned installation effect the life of a shock mount?** **•How is bonding of the engine to the airplane accomplished if the shock mounts are made of rubber?** **•How is the correct torque established on a rubber shock mount?**

Activities	*Check Items*
	Did the student:
Lift or hoist an engine into the mount.	**•Prepare the aircraft or test stand for installation/removal?** **•Attach hoist or lifting sling, planning the operation so that tools, hoists, etc., were readily available?** **•Practice safety during all phases of the operation?** **•Avoid damage to the equipment?** **•Store and secure all equipment and tools at the completion of the engine change?**

REMOVE AND INSTALL A PROPELLER FROM THE PROPELLER SHAFT.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  A propeller on the shaft of a given engine and the appropriate reference information and installation tools.
- **Performance:**
  The student will remove, inspect, set blade angles if necessary, and install a propeller on the propeller shaft of the engine.
- **Standard:**
  The procedure specified in the manual will be followed without exception. The resulting installation will be of return-to-service quality.

Key Points	*Feedback*
Types of propeller shafts.	**•How may a mechanic distinguish between a splined, tapered and flanged type propeller shaft?** **•What type of propeller shaft requires front and rear cones?** **•What is the purpose of cones between the shaft and the propeller?** **•Why is the front cone made in two pieces?** **•Why is a cone spacer sometimes necessary when installing a propeller?** **•What is the "blind" spline of a splined type propeller shaft?** **•Why is the installation position of a propeller important?** **•How is the torque of a propeller retaining nut measured?** **•What importance does a mechanic attach to the torque values for the propeller hub bolts?** **•What is the importance of the track of a propeller?** **•How frequently would a mechanic made a check of the blade angles of a propeller?**

Key Points	Feedback
	•How are propellers safetied to the shaft?

Activities	*Check Items*
	Did the student:
Remove and install a propeller on the propeller shaft of an engine.	•Follow the procedure established in the manual? •Inspect the propeller and shaft properly? •Maintain all tolerances specified for torque, cone bottoming, track, etc.? •Observe and practice safety throughout the procedure? •Correctly safety the installed propeller?

PRE-OILING OF OVERHAULED ENGINES.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  An aircraft engine, pre-oiling equipment and an information sheet detailing the pre-oiling procedure.

- **Performance:**
  The student will describe the pre-oiling of an overhauled engine and explain the purpose of this operation. He will interpret information from the procedure sheet and accomplish the pre-oiling of an engine as a prelude to engine operation.

- **Standard:**
  The pre-oiling procedure will be interpreted and executed without error. The explanations will use correct nomenclature and terminology.

Key Points	*Feedback*
Pre-oiling operations:	•How will air trapped in the oil passages of an engine affect initial lubrication? •Describe the general procedure necessary to prepare an engine for pre-oiling. •How can a mechanic determine when the pre-oiling procedure is completed?
b. Equipment/procedure.	•What internal damage often occures if pre-oiling is not accomplished?

Activities	*Check Items*
	Did the student:
Prepare the engine for pre-oiling. Attach pre-oiling equipment and pre-oil the engine. Disconnect, store equipment and secure the engine. Describe the purpose of the pre-oiling operation.	•Follow the correct procedure? •Practice safety during the operation? •Use correct nomenclature as a part of the explanation?

REMOVE AND REINSTALL BAFFLES.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  An engine that is equipped with baffles and a listing of ten engine operating problems which may or may not be related to improperly fitted baffles, and the manufacturer's manual.

- **Performance:**
  The student will remove and reinstall two or more engine baffles in accordance with the manufacturer's manual. When provided with a list of operational problems that could be associated with improperly fitted baffles, he will explain the corrective action that should be taken.

- **Standard:**
  The student will identify all operational problems appearing in the list that are related to baffling. He will use correct nomenclature while describing corrective actions and will remove and reinstall the baffles without damaging or deforming the baffles and in accordance with manufacturer's specifications.

Key Points	*Feedback*
Baffles:	•Where are baffles generally located?
a. Purpose.	•How will an improperly installed cylinder baffle affect cylinder temperatures?
b. Attachment.	•What types of fasteners are used to attach baffles to an engine? •What materials are used in the construction of baffles?
c. Removal/installation.	•Describe the precautions that should be observed when removing and installing baffles.

- If not specified in the manual, what general considerations apply to the position and fit of baffles on an engine?
- What troubles are most generally associated with defective or improperly installed baffles?
- What design feature is intended to keep a baffle from chafing the cowling and adjacent parts of the airplane?

Activities	*Check Items* Did the student:
Remove and reinstall baffles.	•Plan and follow a sequence for removal and identification of baffle positions? •Follow the procedures specified in the manual? •Exercise care to avoid bending or distorting the baffles?
Describe an action which would correct distortion caused by improper installation of baffles.	•Outline an action that assured the safety of the airplane? •Recommend an action that could be economically justified?

DEMONSTRATE CORRECT ENGINE STARTING PROCEDURES.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  An operable aircraft engine and a written starting "check list."
- **Performance:**
  The student will demonstrate correct procedures while starting an engine. He will describe the effects and recognize symptoms associated with backfire, afterfire, and kickback and the importance of various throttle/mixture positions while starting.
- **Standard:**
  The procedure and performance will be without error and/or hazard.

Key Points	*Feedback*
Throttle operation and function.	•How does throttle position affect starting of an engine? •How will the engine react if the throttle remains completely closed during engine starting? •How does the fuel-air ratio affect the starting of an engine? •In what position should the throttle be placed when attempting to start a "loaded engine"? •How does rapid throttle movement effect the start? •How is throttle position related to the fire hazard that exists while starting an engine? •How do engine temperatures and the temperature of the atmosphere affect the position of the throttle while starting?
Types of fuel metering systems.	•In what manner does the starting procedure for a fuel injected engine differ from the procedure for starting a carbureted engine? •Which fuel metering system will require the use of fuel boost pumps?
Starting difficulties: a. Backfiring. b. Afterfiring. c. Kickback.	•What fuel – air mixture condition is conducive to backfiring? •What will be the effect of sticky valves, broken valve springs, floating valves, etc., to the starting of an engine? •How will a shorted ignition harness affect the starting of an engine? •How will moisture and contamination in the distributor housing of a magneto affect the starting of an engine? •How will a defect in the distributor rotor be defected?

Activities	*Check Items*
	Did the student:
Make a normal cold start of an aircraft engine.	•Follow the starting procedure specified in the manual?
Make a normal hot start.	•Modify the required prime to meet existing temperatures?
Describe effects and recognize symptoms of starting problems.	•Recognize symptoms indicating incorrect throttle positions? •Display proper respect for all safety considerations?

RECOGNIZE SYMPTOMS THAT INDICATE OPERATIONAL DISTRESS.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  A list of twenty symptoms that indicate operational distress due to detonation, exhaust back pressure, leaking primers, and/or carburetor icing.
- Performance:
  The student will correctly associate each symptom with problems related to detonation, exhaust back pressure, leaking primers or carburetor icing.
- Standard:
  The student will recognize the symptom and explain the cause of each of the operational problems. He will describe at least one method of procedure that will minimize the operational distress.

Key Points	*Feedback*
Detonation.	•What is detonation, and how does detonation differ from pre-ignition? •When does detonation most usually occur? •How does detonation effect engine life? •What are some of the factors that cause detonation? •What are some of the factors that cause pre-ignition? •What are some of the precautions or techniques that will minimize detonation? •How does dual ignition reduce the tendency of the mixture to detonate? •How does detonation effect engine power? •What damage may result from detonation? •What are the symptoms of detonation in an automobile? •How is detonation counteracted in an automobile? •Why isn't the same symptom recognizable in an aircraft engine? •What instrument indication will give evidence that an aircraft engine is detonating?
Malfunctioning of primers.	•Where is the priming fuel most generally injected into the induction system of an engine? •Where does the primer system obtain its fuel? •What symptom will indicate an air leak in the induction system of an engine? •What symptom indicates a fuel leak through the primer system of the engine? •What is the effect of a leaking primer while the engine is not operating? •What is the effect of a leaking primer while the engine is operating? What is the effect of the same leak during starting?
Exhaust system back pressure.	•What is exhaust back pressure? •Describe the design features that will cause an exhaust system to have some back pressure during normal operation. •What malfunctions will cause excessive exhaust back pressures? •How does exhaust back pressure effect the power output of an engine? •How can exhaust back pressures be minimized?
Carburetor icing.	•Explain the cooling effect due to vaporization of fuel. •By what three processes may ice be formed in a carburetor? •What cockpit indications alert the operator to the possibility of carburetor ice?

	• What is the difference between de-icing and anti-icing? • When carburetor icing occurs, what corrective action must be taken? • How does the indication of carburetor icing differ if the engine is equipped with a constant speed propeller?

Activities	*Check Items* Did the student:
Recognize listed symptoms and associate operational problems with correct symptoms or causes.	• Correctly associate system, condition and symptom? • Use correct nomenclature when describing the operational difficulty?

OPERATE AN ENGINE EQUIPPED WITH A CONSTANT SPEED PROPELLER AND/OR SUPERCHARGER.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- Given:
  An operable engine equipped with a constant speed propeller and/or supercharger and an operating "check" sheet or manual.
- Performance:
  The student will demonstrate correct operational sequence for increasing and reducing the power output, and controlling RPM. He will explain how master rod bearing loads are affected by increased manifold pressures.
- Standard:
  Operation of the engine will be fully in accord with the operating "check" sheet or manual. Explanations will involve use of correct nomenclature.

Key Points	*Feedback*
Operating constant-speed propellers.	• Why isn't the RPM indicated by the tachometer an indication of power being developed? • How does the propeller control the engine RPM? • Explain the process by which the throttle controls the manifold pressure of the engine? • What is the sequence for increasing/reducing the power of the engine? • How does increasing or decreasing RPM affect the manifold pressure? • How does increasing or decreasing the manifold pressure affect RPM? • Why should an engine always be operated within the manufacturer's recommended manifold pressure ranged?
Effects of air density on engine power.	• What is meant by the density of air? • How will an increase or decrease in temperature or humidity affect engine power? • What are some of the methods of compensating for the varying air densities and the requirement for constant engine power? • What is the difference between a supercharged and a "naturally aspirated" engine? • What are some of the indications of leaks in the induction system of an engine? • How does an induction system leak effect the operation of a supercharged engine? • How does an induction system leak effect the operation of an unsupercharged engine? • Which of the systems (supercharged or unsupercharged) is most susceptible to leaks?

Activities	*Check Items* Did the student:
Prepare an engine for run-up and operate to stabilize temperatures. Perform propeller check and make power setting changes.	• Follow correct procedure for starting, making power changes and shutting down the engine? • Use correct nomenclature as part of the descriptions and explanations.

Shut-down engine and secure.

Explain the relationship of manifold pressures and bearing loads.

5. OVERHAUL TURBINE ENGINES. (EIT = 34 hrs., T = 24 hrs., L/S = 10 hrs.) 11 segments

(UNIT LEVEL 2)

ILLUSTRATE NEWTON'S LAWS AND THE BRAYTON CYCLE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:

  A line drawing or sketch of a turbine engine and appropriate reference information.

- Performance:

  Provided with a line drawing or sketch, the student will label the sections of a turbine engine and draw arrows to illustrate the application of Newton's second and third laws of motion and explain the Brayton cycle and principles of turbine engine operation.

- Standard:

  Correct terminology and nomenclature will be used to label the diagram and explain the theory of turbine engine operation.

Key Points	*Feedback*
Sections of a turbine engine:	•What name is given to that section of the engine where the air is admitted?
a. Function of each part.	•What section of the engine operates at the highest temperature? •What section is exposed to the greater air pressures? •What parts are subjected to the greatest centrifugal forces?
Operating principles: a. Newton's laws. b. Boyle's law. c. Charles' law. d. First law of thermodynamics. e. Second law of thermodynamics.	•Give an example of the application of each of these laws to the operation of a turbine engine.

Activities	*Check Items* Did the student:
Diagram and label the sketch illustrating the principles of operation of a jet engine.	•Clearly illustrate the principles?
Explain the operation of a jet engine.	•Use correct nomenclature and terminology?

EXPLAIN RELATIONSHIP OF RPM AND THRUST IN A TURBINE ENGINE.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:

  A chart and reference information comparing turbine inlet temperatures to thrust and the relationship of RPM to thrust in a turbine engine.

- Performance:

  Provided with appropriate reference information, the student will interpret the manufacturer's manuals and charts and explain the relationship of RPM to thrust and the relationship of turbine inlet temperature vs. thrust. He will explain how estimates of thrust can be made. He will illustrate and explain why an engine produces less thrust as altitude increases.

- Standard:

  Correct nomenclature will be used during all explanations. Appropriate references will be cited and correctly interpreted.

Key Points	*Feedback*
Effect of RPM on thrust:	•Why does a relatively slight increase in RPM have a relatively greater effect on thrust at the higher speeds?
a. At lower RPM.	
b. At high RPM.	•What instrument is used to indicate rotor RPM of a turbine engine? Is this an indication of turbine or compressor speed? •What instrument is used to indicate thrust of a turbine engine?
Air density vs. thrust.	•How does temperature affect air density?
a. On a standard day.	•Which is more dense, dry or moist air?
b. At altitude.	•What is a "standard" day and "standard" air temperature?
c. At varying barometric pressures.	•Why does an increase in air temperature decrease the thrust of the engine?

	•How does barometric pressure effect the thrust of the engine?

Activities	*Check Items*
	Did the student:
Explain and illustrate relationship of RPM, thrust, and inlet temperatures.	•Correctly interpret technical data? •Use correct nomenclature and terminology as a part of the explanations?

IDENTIFY AND EXPLAIN THE CHARACTERISTICS OF DIFFERENT TURBINE COMPRESSORS.

(SEGMENT C, LEVEL 2)

Student Performance Goal:

- Given:
  Unlabeled sketches illustrating the various types of compressors and ten statements describing the characteristics, advantages and limitations of turbine compressors.

- Performance:
  Provided with unlabeled sketches illustrating the various types of compressors, the student will identify the type of compressor, label the sketch, and explain the airflow characteristic of each type. From a list of ten statements which describe the characteristics, advantages and limitations applicable to the various turbine compressors, he will associate three characteristics with each type of compressor.

- Standard:
  The sketches will be correctly labeled. Correct terminology will be used as a part of the explanations.

Key Points	*Feedback*
Centrifugal compressors:	•What are the limits to the compression ratios that may be attained with a centrifugal compressor?
a. Single vs. double-sided.	•What type of compressor is required to achieve a compression ratio of 13 to 1 and higher?
Axial compressors:	•How is air re-directed in the compressor so that it will properly impinge on the next state of compression?
a. Single spool.	
b. Dual spool.	•Describe some of the advantages of an axial flow over a centrifugal flow compressor.
c. Triple spool.	•How is it possible to attain higher compression ratio with a dual spool compressor?
d. Variable stator.	•In a dual spool compressor, which compressor is identified as N1? •In a dual spool compressor, which spool operates at the higher speed? •In a triple spool compressor what are the functions of each stage? What are the advantages of each of the spool designs? •What are the advantages and disadvantages of variable stators? •How are the variable stators controlled? •Why is it necessary to limit thrust during reversal on variable stator engines? •How is the angle of variable stators checked?

Activities

Activities	*Check Items*
	Did the student:
Label the sketches and indicate airflow through the compressor. Identify the characteristics, limitations and advantages of the turbine compressors.	•Use the correct nomenclature in labeling the sketches? •Correctly associate the statements with each type of compressor?

IDENTIFY MAJOR COMPONENTS AND EXPLAIN AIRFLOW IN FAN OR BY-PASS TURBINE ENGINES.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  A sketch or line diagram of a fan or by-pass engine and appropriate reference information.

- Performance:
  The student will label the diagrams, identify the major components and indicate by means of arrows, the direction of airflows through the engines. He will interpret the reference information and explain the operating theory underlying each engine design.

- Standard:
  The sketches will be correctly labeled. Correct terminology will be used as a part of the explanation of engine theory.

Key Points	*Feedback*
Fan and by-pass engines.	• What are some of the advantages of a fan engine? • What is the most identifiable feature of a fan engine? • Describe some of the differences between a standard turbine engine, and by-pass type of engine.

Activities	*Check Items*
	Did the student:
Label the diagrams, identifying major components and airflow. Explain the theory of operation.	• Correctly identify the components in each type of engine? • Use correct nomenclature?

IDENTIFY PRESSURE CHANGES IN A TURBINE ENGINE.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:
  A sketch of a turbine engine and appropriate reference information.

- Performance:
  Provided with appropriate reference information and a sketch of a turbine engine, the student will interpret the information and identify on the sketch the areas of the engine where significant pressure changes occur.

- Standard:
  The sketch will illustrate at least the pressure changes occurring between the air inlet, the compressor, the combustion chamber and exhaust nozzle. Explanations and labeling of sketches will reflect correct nomenclature and terminology.

Key Points	*Feedback*
Air pressure variations.	• Where does the highest gas pressure occur in a jet engine? • Why does the compressor blade angle and the size of the compressor blade change from stage to stage of the compressor? • What would happen if any single stage did not increase pressure? • Why does the pressure drop in the combustion area of a turbine engine? • How is pressure related to velocity of air within the engine?

Activities	*Check Items*
	Did the student:
Sketch and describe the relative pressures in the various sections of a jet engine.	• Correctly interpret the reference information? • Use correct nomenclature as a part of the explanations?

IDENTIFY AIRFLOW IN DIFFUSERS.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  Mock-ups, visual aids or line drawings of subsonic and supersonic diffusers and appropriate reference information.

- Performance:
  The student will point to the diffuser section of a turbine engine and explain the relationship of the diffuser to the compressor and combustion chamber. Provided with appropriate references, he will interpret the information necessary to distinguish between subsonic and supersonic diffusers and describe the airflow characteristics of each type.

- Standard:
  Identification of diffusers will be without error. Correct nomenclature will be used throughout all descriptions and explanations.

Key Points	*Feedback*
Diffusers: a. Subsonic. b. Supersonic. c. Shape, function and location.	• Where is a subsonic diffuser generally located within a turbine engine? • Where is a supersonic diffuser generally located? • What characteristics and shapes assist a mechanic in the identification of sub and supersonic diffusers? • How would an air velocity of Mach .82 be classified, i.e., sub or supersonic? • Explain how subsonic and supersonic diffusers both act to reduce velocity and increase static pressures.

Activities	*Check Items*
	Did the student:
Identify types of diffusers.	•Use correct nomenclature and terminology?
Describe the location of diffusers.	•Correctly identify types and locations of diffusers?
Explain the airflow through subsonic and supersonic diffusers.	

IDENTIFY TYPES AND CHARACTERISTICS OF COMBUSTION CHAMBERS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- Given:
  Various types of combustion chambers and line drawings illustrating the different types and appropriate reference information.

- Performance:
  From the displayed combustion chambers, the student will identify the various types and explain the operating characteristics of each type. He will draw arrows on the line sketches to illustrate the airflow and flame paths through each type of combustion chamber.

- Standard:
  The types of combustion chambers will be identified without error. Correct nomenclature will be used as a part of all descriptions and explanations.

Key Points	*Feedback*
Types of combustion chambers.	•Compare the advantages/limitations of each type of combustion chamber.
a. Can. b. Annular. c. Can-annular. d. Air flows.	•At what location within the combustion chamber does combustion take place? •What percent of engine air goes to combustion? •How does secondary air enter the combustion can?
e. Flame propagation.	•At the time of ignition (during starting) what is the approximate fuel-air ratio at the igniter plug? •What is an ignition eddy? •How many igniters are generally used in turbine engines? •In an engine that incorporates individual cans, how is flame transferred from one can to another? •How would minimum flow solenoid affect engine operation above critical altitude?
f. Nozzle arrangement.	•Where are the fuel nozzles located in each of the various types of combustion chambers?

Activities	*Check Items*
	Did the student:
Identify types of combustion chambers.	•Use correct nomenclature throughout the descriptions and explanations?
Illustrate airflow and flame path in combustion chambers.	•Correctly interpret reference information?

IDENTIFY IMPULSE AND REACTION BLADES AND THRUST REVERSERS.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  Examples of impulse, reaction, and impulse-reaction type turbine blades, sketches or line drawings of the types of turbine engine blades and thrust reversing systems and appropriate reference information.

- Performance:
  The student will identify each type of turbine blade. Using the line drawings or sketches, he will illustrate the characteristics of each type of blade and label the reverser drawing and describe the gas flow around the exhaust cone of a turbine engine.

- Standard:
  The types of turbine blades will be identified without error. The descriptions and explanations will display correct nomenclature and terminology.

Key Points	*Feedback*
Types of turbine blades:	•Compare the changes in air velocity that may be achieved by the impulse and the reaction type blade.
a. Impulse. b. Reaction. c. Impulse-reaction.	•What are the pressure changes in the impulse and reaction type blades? •What are the advantages of the combination "impulse-reaction" type turbine blade?
Exhause nozzles:	•Why is an exhause cone position close to the rear turbine face?
a. Shapes. b. Guides and support vanes.	•What are two functions of the guide vanes?

c. Cooling.	•What are the airflow characteristics in the exhaust cone area?
Thrust reversers.	•Why is thrust reversing required? •How is the airflow of a fan-jet engine reversed? •What methods may be used to actuate the thrust reversers? •What methods may be used to reduce the possibility of reingestion into a reversed turbine engine? •What fail-safe features may be incorporated into the reversing system?

Activities	*Check Items*
	Did the student:
Identify types of blades in sample display. Sketch and explain the characteristics of the different blades. Describe the airflow around the exhaust cone in two different types of thrust reversers.	•Make correct identification of the components? •Use correct nomenclature and terminology as a part of the descriptions and explanations?

COMPARE CHARACTERISTICS OF TURBOPROP AND RECIPROCATING ENGINES.

(SEGMENT I, LEVEL 1)

Student Performance Goal

- Given:
  Twenty statements which identify the fuel consumption, specific weight, maintenance and operational characteristics of turboprop and reciprocating engines.
- Performance:
  The student will arrange the statements in two columns. One column will list all statements applicable to a turboprop engine, the second column will record statements applicable to reciprocating engines.
- Standard:
  The student will correctly associate 70 percent of the statement with the type of powerplant.

Key Points	*Feedback*
Comparison of turboprop with a reciprocating engine.	•What is a turboprop engine? •What is the best operating speed range for an airplane powered by a turboprop engine? •What fuels are used in a turboprop engine? •Why may two stages of propeller reduction be required for a turboprop engine?
Turboprop operation.	•Explain how the thrust of a propjet is augmented by the thrust of the exhaust gasses. •Compare the weight to power ratio of propjet and reciprocating engines. •How does the time between overhaul periods of a turboprop engine compare with a piston engine? •How do the two types of engines compare in fuel consumption?

OVERHAUL TURBINE ENGINE.

(SEGMENT J, LEVEL 2)

Student Performance Goal

- Given:
  Written information, turbine engine diagrams, a turbine engine, selected parts from a turbine engine, appropriate measuring devices, and an overhaul manual.
- Performance:
  The student will identify the major parts of the turbine engine by writing the names of the parts on a diagram. He will inspect and make recommendations for repair according to the overhaul manual table of limits, as well as write recommendations for reuse or suggested types of repairs.
- Standard:
  The listing of parts on the diagram and determination for serviceability of engine parts will be 100 percent accurate and recommendations for reuse or repair will be within the limits established by the overhaul manual in use.

Key Points	*Feedback*
Disassembly	• How are cradles attached to the engine for disassembly?
	• How is an engine mounted for horizontal disassembly?
	• How is an engine mounted for vertical disassembly?
	• When is QEC equipment removed?
	• How is the overhaul manual used in disassembling an engine?
	• What section is disassembled first?
	• What precautions should be taken to protect bearings and seals?
	• How are cases indexed during disassembly?
	• How are blades protected during disassembly?
	• What methods are approved for marking hot section components?
Cleaning.	• How do you clean parts not subjected to extreme heat?
	• How do you clean parts that are subjected to heat?
	• Why and when is electrolytic cleaning used?
	• What types of cleaners should be used for parts coated with metal spray, titanium weldments, chrome plating, flame-plated and plasma sprayed parts, and nickel cadmium plating?
	• What precautions should be used in cleaning blind holes?
	• How does triclorethylene effect titanium?
Inspection.	• How is corrosion prevented during and after inspection?
	• Describe the uses of physical, magnetic, particle, flourescent, penetrant, surface treatment, gage, and X-ray inspection.
	• How are engine welds inspected?
	• How are blades inspected?
	• How is part re-use determined?
	• What determines maximum allowable repair limits?
	• Why is indexing of parts so important to malfunction analysis?
Repair	• How is the repairability of parts determined?
	• How are parts repaired so as to bring them back into factory specifications?
	• What factors should be considered when lapping and grinding parts?
	• How are tube assemblies pressure checked?
	• How is the acceptability of a repair determined?
	• What parts can be repaired by welding?
	• After welded repairs are made, how are parts relieved of stress?
	• What is the reason for plasma spraying?
	• What are the criteria for using rivets within the engine?
	• What is the process of honeycomb replacement?
	• What parts are not generally re-used?
	• How are serviceable seals and packings stored?
	• How is magnesium welding rod handled, stored, and used?
	• What is done with magnesium welding rod after being partially used?
	• What is the process of welding magnesium parts?
Sub Assembly.	• Why is assembly order important?
	• What precautions must be taken to prevent dust, dirt and small objects from entering the engine?
	• What precautions must be used when assembling parts covered with corrosion preventive compounds?
	• What parts of the engine are dynamically balanced?
	• What determines the sequence of build up of sub-assemblies?
	• How are built-up sub-assemblies stored?
	• What are the advantages of "J" threaded bolts and how should they be stored with other bolts?

Final assembly.	• What are the general procedures for mating sub-assemblies? • What are the major differences between horizontal and vertical build-up? • What can be done to facilitate snap-fit installations? • How is alignment achieved in hard-to-see places? • What methods are used to check fits and clearances?
Storage.	• How long can an engine remain inactive before preservative protection is required? • What is the purpose of humidity indicators? • How are overhaul records kept for stored engines? • How is an engine "pickled"? • How is an engine maintained in storage?

Activities	*Check Items*
	Did the student:
List part names on diagram.	• List the correct names within a reasonable period of time?
Inspect parts.	• Properly measure parts? • Safely use measuring devices?
Determine parts serviceability.	• Accurately determine parts serviceability?
Write recommendations for repair.	• Recommend appropriate types of repair or reuse?

DESCRIBE MODULAR OVERHAUL.

(SEGMENT K, LEVEL 1)

Student Performance Goal

- Given:
  Controlled notes, written information, and matching test.
- Performance:
  The student will complete the matching test and will cite cases when modular overhaul is appropriate.
- Standard:
  The matching test and cited statements will be 80 percent accurate.

Key Points	*Feedback*
Modular Overhaul.	• What are the advantages of modular overhaul? • How does logbook analysis effect engine repair?
Time Repairs.	• What parts of the engine are related to time repairs or removals? • How is time maintenance scheduled? • How is modular overhaul effected by on-condition maintenance compared to time-determined maintenance?
Malfunction removals.	• What determines whether an engine will be repaired on-the-wing or removed for repair? • What sub-assemblies can be repaired? • Can the compressor(s) be repaired or replaced on-the-wing?
Inspection removals.	• How is an engine internally inspected on-the-wing? • Compare the use of X-ray and boroscope inspections. • How is alcohol and talcum powder used to detect leaks?
Repair techniques.	• What are the purposes of the rails? • When is a lifting device needed? • How is alignment maintained? • Why are rails unnecessary for hot section replacements?

6. INSPECT, CHECK, SERVICE, AND REPAIR TURBINE ENGINE INSTALLATIONS. (EIT = 10 hrs., T = 5.0 hrs., L/S = 5 hrs.) 3 segments

(UNIT LEVEL 2)

REMOVE AND INSTALL A COMBUSTION CASE AND LINER.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  A turbine engine incorporating a combustion case and liner, an appropriate manual or instruction sheet and the required special tools and equipment.
- Performance:
  The student will remove and install a combustion case and liner in an engine.
- Standard:
  The student will correctly interpret the instructions and follow all procedures regarding uses of special tools, torque values and safety practices.

Key Points	*Feedback*
Procedure.	• **What methods of support may be required for associated parts of the engine while the burner can is removed?** • **Why is it important to mark the original position of the parts prior to removal from the engine?** • **Why is it necessary that the parts be maintained in their proper relationship to each other?** • **What possible effect could a lead pencil mark have on the parts of a jet engine?** • **Why may the manual specify the use of an anti-seize compound during assembly of the engine?** • **What are some of the effects of incorrect mating and alignment of new parts into an engine?**

Activities	*Check Items*
	Did the student:
Remove and reinstall a combustion case and liner assembly.	• **Follow the procedure specified with respect to:** **a. Sequence of operations?** **b. Torquing of fasteners?** **c. Use of anti-seize compounds?** • **Observe safety?**

DISASSEMBLE AND REASSEMBLE COMPRESSOR SECTION OF A TURBINE ENGINE.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  A typical turbine engine (or turbine engine compressor section), the manufacturer's overhaul manual and the specified tools and special equipment.

- **Performance:**
  The student will locate and interpret information contained in the manual as a prelude to developing a written outline listing the procedure, tools and safety precautions to be observed when disassembling the compressor section of a turbine engine. He will remove and reinstall some portion of a compressor section without damage to the engine or components.

- **Standard:**
  Interpretation of procedures appearing in the manuals will be without error. Removal and reinstallation of a portion of compressor section will be fully in accord with the specified procedures.

Key Points	*Feedback*
Procedures:	• **What are the advantages of vertical assembly and disassembly?**
a. Position of the engine for disassembly and reassembly.	• **Why is it important that parts removed from the engine be carefully handled?**
b. Sequence of work.	• **What methods may be used to identify the position of parts removed from the engine?** • **Why is it important that a part be reinstalled in its original position?**
c. Safety.	• **Describe some of the safety precautions that should be observed during disassembly and reassembly of compressor sections.** • **How can a mechanic determine the requirement for special tools and equipment?**

Activities	*Check Items*
	Did the student:
Remove and replace a section of a compressor.	• **Correctly interpret the manual and follow the specified procedures?** • **Observe safety precautions?**

REMOVE AND REINSTALL A FUEL NOZZLE IN A TURBINE ENGINE.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  A turbine engine or mock-up, the manufacturer's instructions and the necessary special tools.

- **Performance:**
  The student will make a sketch or line drawing illustrating the fuel nozzle arrangement in various types of engines. He will remove and reinstall a fuel nozzle in an engine without damaging the nozzle or components and will explain the fuel flow through the nozzle.

- **Standard:**
  Correct nomenclature will be used as a part of all descriptions and explanations. Removal and reinstallation of the fuel nozzle will be at return-to-service standard.

Key Points	*Feedback*
Fuel nozzles.	• What is the advantage of a duplex nozzle over a simplex type nozzle? • Why is the nozzle designed so that the fuel delivered from the nozzle is in a swirl pattern? • What devices are incorporated in the nozzles to prevent clogging? • What will probably result if the fuel nozzles in an engine are improperly assembled or installed?

Activities	*Check Items*
	Did the student:
Make a sketch illustrating location of nozzles in various engines.	• Correctly interpret reference information? • Follow procedures and techniques specified for installation and removal of nozzle?
Remove and reinstall nozzle.	• Avoid damaging the components?

7. REMOVE, INSTALL, AND TROUBLESHOOT TURBINE ENGINES. (EIT = 10½ hrs., T = 5 hrs., L/S = 5½ hrs.) 7 segments

(UNIT LEVEL 2)

IDENTIFY DAMAGED TURBINE BLADES.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Random display of 20 blades from a turbine engine, some of which display damage as a result of excessive operating temperatures.

- **Performance:**
  The student will recognize and select those blades that show evidence of being overheated, blade creep, scraping, and other deformations.

- **Standard:**
  The student will correctly identify 70 percent of the overheated blades.

Key Points	*Feedback*
Factors influencing the temperature on blades.	• What is a hot start? • How do the operating temperatures of the engine respond to higher outside air temperatures? • How do variations in fuel flow effect the operating temperatures of the engine? • How does cold weather operation affect the operating temperatures at the turbine blade?
Inspection of engine components subjected to heat.	• What parts of an engine will be affected by heat? • What is "stretch" of an engine component? • What is "creep" of an engine component? • What causes ovality of a turbine case?

RECOGNIZE AND IDENTIFY COMBUSTION CHAMBER HOT SPOTS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Typical combustion chambers from turbine engines and the manufacturer's maintenance publications.

- **Performance:**
  When handed a combustion chamber, the student will identify a combustion chamber hot spot. He will explain the two causes of hot spots in the outer combustion casing. He will interpret information contained in the manual as a part of a demonstration showing how the alignment and spray pattern of a fuel nozzle is checked.

- **Standard:**
  The student will promptly and correctly recognize hot spots. He will use the correct nomenclature and terminology as part of the explanations and interpretation of information contained in the manual.

Key Points	*Feedback*
Combustion chamber hot spots:	• What precautions should be observed when installing external type fuel nozzles?
a. Causes/effects.	• What are some probable causes of incorrect spray pattern from the nozzles? • What precautions should be observed when installing a combustion liner with external fuel nozzles?

	•What may cause a combustion chamber or burner can to shift or change its position? •How can chafing damage a combustion chamber? •How may incorrect position of the fuel nozzle effect the burner can?

Activities	*Check Items*
	Did the student:
Identify hot spots in a combustion chamber. Demonstrate procedure to check alignment and pattern of fuel nozzles.	•Correctly interpret information from the manual? •Use correct nomenclature and terminology as a part of the explanation and demonstration?

ADJUST FUEL CONTROL OF A TURBINE ENGINE.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A turbine engine (simulator or mock-up) including the fuel control unit and the manufacturer's service/operations manual.
- Performance:
  The student will describe the operation of the fuel control unit of a turbine engine from idle speed range through to full power. On the mock-up or simulated engine, he will demonstrate the procedure for adjusting the fuel control unit.
- Standard:
  Correct nomenclature will be used throughout the demonstration and description of operation. The student will correctly interpret information from the manual and make adjustments as specified.

Key Points	*Feedback*
Fuel control units:	•What feature of the fuel control unit is intended to prevent rich-mixture flame-out?
a. Operating principles.	•What is the purpose of the pressure regulator valve? •What is the purpose of the minimum pressure shut-off valve? •What are the three variables that affect the amount of thrust that an engine will produce for any given fuel flow?
b. Field adjustments.	•What maintenance may a mechanic perform on the fuel control unit? •What is meant by the expression, "trim an engine"?

Activities	*Check Items*
	Did the student:
Demonstrate the procedure to: a. Adjust idle RPM. b. Adjust maximum RPM. c Safety the fuel control.	•Correctly interpret the manual? •Describe the hazards and demonstrate regard for the hazards that are involved under "actual" operating conditions?

RECOGNIZE THE EFFECTS OF EXHAUST NOZZLE AREA.

(SEGMENT D, LEVEL 1)

Student Performance Goal

- Given:
  Twenty statements describing operating conditions which may result in changes in fuel consumption, exhaust gas velocities and tail pipe temperatures of turbine engines.
- Performance:
  The student will recognize the conditions that are related to changes in exhaust nozzle area, and explain the reason for selecting each answer.
- Standard:
  The student will recognize 70 percent of the conditions.

Key Points	*Feedback*
Tail pipes and exhaust nozzles:	•How does the area of the tailpipe affect exhaust gas temperature?
a. Shapes. b. Areas.	•What is "EPR" and "EGT"? •What are some of the methods for varying or controlling the area of a tailpipe? •What features and characteristics are associated with the convergent type exhaust nozzle? •How does a convergent-divergent exhaust nozzle differ from a convergent nozzle?

IDENTIFY COMPRESSOR SURGE:

(SEGMENT E, LEVEL 1)

Student Performance Goal

- **Given:**
  A written information sheet identifying the causes and methods of controlling compressor surge in turbine engines.

- **Performance:**
  The student will distinguish between the causes and methods of control.

- **Standard:**
  When given a matching type questionnaire, the student will associate the causes and methods of control with 70 percent accuracy.

Key Points	*Feedback*
Compressor surge.	• What are some of the causes of compressor surge? • What methods of controlling compressor surge proved satisfactory for centrifugal compressors? • What methods of controlling compressor surge are used in axial flow engines? • What is the effect of rapid throttle movement, i.e., "jamming" a throttle? • Under what operating conditions is compressor surge most likely to occur? • How do variable stators act to control surge of a compressor? • How do compressor bleed valves and bleed straps act to limit surge of the engine? • Where are bleed valves located within an engine? • How may feed control scheduling act to limit compressor surge?

IDENTIFY CAUSES FOR PERFORMANCE LOSS

(SEGMENT F, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information identifying the causes and methods for determining performance loss in turbine engines.

- **Performance:**
  The student will identify four basic causes of engine performance deterioration and methods of detecting these causes.

- **Standard:**
  When given a matching type questionnaire, the student will associate the causes for power loss with their related symptoms.

Key Points	*Feedback*
Compressor Deterioration.	• What causes compressor deterioration – FOD? • What causes compressor deterioration – water contamination? • What does white film on blades indicate? • When is carbo-blast used? • What causes compressor stall? • Why does abnormal airflow cause compressor stall?
Turbine deterioration.	• How is a boroscope used to detect bowed nozzle guide vanes, eroded nozzle guide vanes, and burner can alignment? • Explain why high EGT *and* fuel flow is not a fuel control problem. • What do you look for when visually inspecting turbines? • What does a straw-colored turbine wheel indicate?
Instrument Problems.	• How does seal deterioration effect EPR readings? • How do eroded turbine blades effect EPR? • How would a PT_2 leak effect EPR? • How would a PT_7 leak effect EPR? • What would low RPM and EGT with a high EPR indicate?
Lubrication problems.	• How can an air-oil seal leak be detected? • What effect would high breather pressure have upon oil pressure? • What would be indicated by an illuminated oil bypass light? • On a constant volume oil pressure system, what would high oil pressure indicate?

- Why and where are breather pressure checks made?
- If an internal leak developed in a fuel cooled oil cooler which liquid would go to where?

REMOVAL AND INSTALLATION OF TURBINE ENGINE.

(SEGMENT G, LEVEL 1)

Student Performance Goal

- **Given:**
  Controlled notes containing procedural steps, written information, and appropriate 35mm colored slides.
- **Performance:**
  The student will list necessary steps for turbine engine removal and installation.
- **Standard:**
  All steps will be correct and in an acceptable sequence.

Key Points	*Feedback*
Tools and equipment.	• What special tools are needed? • What special equipment is needed? • What materials are needed to maintain a clean and safe working area?
Engine removal and installation.	• What safety precaution should be taken in regard to work stands, electrical power, and fluid shut-off? • How are connectors and openings capped for protection? • What should be considered when removing and installing engine mount bolts? • What safety precautions should be taken with engine hoists? • What precautions should be taken when reconnecting electrical fluid, and pneumatic connections? • What precautions must be taken when extensions are used with torqueing tools?
Checking engine systems.	• How is pre-oiling accomplished? • What control functions require rigging? • What precautions should be taken in safetying with regard to proper security and protection from injury? • How are fluid checks made? • How are electrical checks made? • How are pneumatic checks made? • How are mechanical control checks made? • What final checks must be made before run-up? • What is used to determine if engine operation is within limits?

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8. PERFORM POWERPLANT CONFORMITY AND AIRWORTHINESS INSPECTION. (EIT = 10 hrs., T = 3 hrs., L/S = 7 hrs.) 2 segments

(UNIT LEVEL 3)

INSPECT AN ENGINE FOR COMPLIANCE WITH AIRWORTHINESS DIRECTIVES.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  An aircraft engine, complete with all accessories, a file or airworthiness directives, the logbook and other maintenance records for the specific engine and the engine manufacturer's manuals and service bulletins.
- Performance:
  The student will inspect the engine and accessories and determine whether the airworthiness directives have been complied with.
- Standard:
  The student will locate and interpret the directives without error. He will research the engine maintenance records and correctly determine whether the required maintenance has been accomplished.

Key Points	*Feedback*
Applicability of directives.	•How may a mechanic determine whether the Airworthiness Directive file is current? •When will an Airworthiness Directive probably require immediate compliance? •Under what conditions may compliance with an Airworthiness Directive be deferred? •Who is legally responsible for compliance with an Airworthiness Directive?
Maintenance record entries.	•What are some of the methods used to mark equipment as an indication that compliance with Airworthiness Directives has been accomplished? •Who is authorized to make entries in the maintenance records?

Activities	*Check Items* Did the student:
Inspect engine and accessories for AD compliance.	•Check data plate and maintenance records to determine applicability of serial numbers? •Correctly interpret Airworthiness Directives and other maintenance records? •Inspect the engine and accessories? •Correctly judge compliance?

INSPECT AN ENGINE FOR CONFORMITY WITH SPECIFICATIONS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An aircraft engine complete with all accessories, (turbine or reciprocating) the FAA specifications and manufacturer's publications.
- Performance:
  The student will inspect the engine and judge whether the engine and its accessories comply with the FAA and manufacturer's specifications.
- Standard:
  The engine and accessories need not be operable, but must have all required identification and data plates. The student will interpret the specifications and identify required equipment without error.

Key Points	*Feedback*
Applicability of specifications and manuals.	•How would a mechanic positively identify an engine? •What importance should a mechanic attach to the "dash" number or letter of a basic engine model? •What method should a mechanic use to identify engine accessories or components? •At the time that a component is installed on an engine, who is responsible for determining that the component complies with the FAA and the manufacturer's specifications?

Activities	*Check Items* **Did the student:**
Inspect an engine and accessories for conformity.	**•Correctly determine applicability by reference to model and serial numbers?** **•Correctly interpret specifications?** **•Inspect the engine and accessories and correctly judge whether the assembly complied with specifications?**

OUTLINE POWERPLANT CURRICULUM – PART II, POWERPLANT SYSTEMS AND COMPONENTS

Instructional Units, Segments, and Estimated Instructional Time

LUBRICATION SYSTEMS

1. IDENTIFY AND SELECT LUBRICANTS. - Level 2 10.5 hrs.
   - A. Identify characteristics of lubricants. - Level 1
   - B. Identify the secondary functions of lubricating oils. - Level 1
   - C. Recognize and identify acceptable lubricants. - Level 2
2. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE LUBRICATION SYSTEMS. - Level 3 40.5 hrs.
   - A. Diagram and explain the operation of wet and dry sump lubrication systems. - Level 2
   - B. Change oil, check screens. - Level 3
   - C. Service an oil by-pass valve. - Level 3
   - D. Service disc-type oil filters. - Level 3
   - E. Describe purpose of oil pressure gauge line restrictors. - Level 2
   - F. Identify components of an oil scavenging system and describe operation of the system and troubleshoot. - Level 2
   - G. Interpret FAA regulations pertaining to oil supply tanks. - Level 2
   - H. Explain the purpose and describe the operation of an oil dilution system. - Level 2
   - I. Adjust oil pressure on an operable engine. - Level 2
   - J. Interpret instrument indications. - Level 2
   - K. Describe the lubrication of a valve mechanism. - Level 2
   - L. Install rings on a piston and describe the factors effecting oil consumption in a piston engine. - Level 3
3. REPAIR ENGINE LUBRICATION SYSTEM COMPONENTS. - Level 2 18.0 hrs.
   - A. Inspect, remove, clean and reinstall oil lines. - Level 2
   - B. Identify and describe oil temperature regulation. - Level 2
   - C. Explain the procedure for cleaning and testing oil tanks. - Level 1
   - D. Disassemble and reassemble an engine oil pump. - Level 2

Estimated Instructional Time . . . . . 69.0 hrs.

ENGINE FUEL SYSTEMS

4. INSPECT, CHECK, SERVICE, TROUBLESHOOT, AND REPAIR ENGINE FUEL SYSTEMS. - Level 3 5.0 hrs.
   - A. Interpret Federal Aviation Regulations governing fuel systems. - Level 2

B. **Inspect, check, service, troubleshoot and repair an engine fuel system.** - Level 3

5. REPAIR ENGINE FUEL SYSTEM COMPONENTS. - Level 2 8.5 hrs.

   A. **Describe the operation of fuel pumps and remove and install a pump on an engine.** - Level 2

   B. **Describe the operation of auxiliary and boost pumps, remove and install an auxiliary or boost pump in a system.** - Level 2

Estimated Instructional Time . . . . . 13.5 hrs.

FUEL METERING SYSTEMS

6. INSPECT, CHECK, SERVICE, TROUBLESHOOT, AND REPAIR RECIPROCATING AND TURBINE ENGINE FUEL METERING SYSTEMS. - Level 3 30.0 hrs.

   A. **Explain temperature, pressure, and humidity effects on operation of a carburetor.** - Level 2

   B. **Describe the operation of a float carburetor.** - Level 2

   C. **Identify a pressure type carburetor and a direct fuel injection system and describe the operation of each system.** - Level 2

   D. **Explain the function of vapor separators and vapor vents.** - Level 2

   E. **Compare continuous flow fuel injection and direct cylinder injection systems.** - Level 1

   F. **Inspect, remove and install a float type carburetor, operate the engine and adjust idle speed and idle mixture.** - Level 3

   G. **Inspect, remove and install a pressure carburetor or fuel injection system, operate the engine and adjust idle speed and idle mixture.** - Level 3

   H. **Identify the dangers of excessively rich and excessively lean fuel-air mixtures.** - Level 2

   I. **Rig the fuel control unit on a static turbojet engine and describe the trimming of the engine.** - Level 2

7. OVERHAUL CARBURETORS. - Level 2 20.0 hrs.

   A. **Identify venturi size and describe function.** - Level 2

   B. **Interpret and use charts or diagrams to explain fuel and airflow through float and pressure carburetors.** - Level 2

   C. **Remove, install and explain the principles of fuel metering through a jet.** - Level 2

   D. **Identify and describe the operation of an air bleed.** - Level 2

   E. **Locate and describe the operation of the main discharge nozzles in a pressure carburetor.** - Level 2

   F. **Identify acceleration systems in float and pressure carburetors and describe the operation of each system.** - Level 2

G. Identify economizer and power enrichment systems and describe the operation of the systems in float and pressure type carburetors. - Level 2

H. Identify mixture controls incorporated in float and pressure carburetors and describe the operation of the system. - Level 2

8. REPAIR ENGINE FUEL METERING SYSTEM COMPONENTS. - Level 2 6.0 hrs.

A. Locate, remove, clean and reinstall screens in fuel metering system components. - Level 2

B. Inspect and describe the repair of carburetor floats. - Level 2

C. Inspect float needle and seat, measure and adjust float level of a carburetor. - Level 2

D. Inspect a pressure type carburetor and describe operation resulting from clogged impact tubes and ruptured diaphragms. - Level 2

9. INSPECT, CHECK, AND SERVICE WATER INJECTION SYSTEMS. - Level 1 2.0 hrs.

A. Locate information regarding the inspection, checking and servicing of water injection systems. - Level 1

Estimated Instructional Time . . . . . 58.0 hrs.

INDUCTION SYSTEMS

10. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR ENGINE ICE AND RAIN CONTROL SYSTEMS. - Level 2 4.5 hrs.

A. Describe induction icing and identify probable location. - Level 2

B. Inspect, check, service and repair a carburetor pre-heat system or hot spot. - Level 2

C. Describe the operation of thermal anti-icing systems for turbine engine air intakes. - Level 2

11. INSPECT, CHECK, SERVICE, AND REPAIR HEAT EXCHANGERS AND SUPERCHARGERS. - Level 2 7.5 hrs.

A. Inspection and repair of superchargers. - Level 2

B. Inspect, service and check a supercharger system. - Level 2

C. Inspect heat exchangers and describe methods of repair. - Level 2

12. INSPECT, CHECK, SERVICE AND REPAIR CARBURETOR AIR INTAKE AND INDUCTION MANIFOLDS. - Level 3 6.5 hrs.

A. Inspect, check, service and repair an air intake duct for a carbureted engine. - Level 3

B. Inspect, check, service and repair a carburetor heater system. - Level 3

C. Inspect and service air screens or air filters in the engine air intake. - Level 3

D. Inspect, check, service and repair an engine primer system. - Level 3

Estimated Instructional Time . . . . . 18.5 hrs.

ENGINE COOLING SYSTEMS

13. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR ENGINE COOLING SYSTEMS. - Level 3 7.0 hrs.

A. Inspect, check, and service engine cooling systems. - Level 3

B. Troubleshoot and repair engine cooling systems. - Level 3

14. REPAIR ENGINE COOLING SYSTEM COMPONENTS. - Level 2 3.0 hrs.

A. Repair baffles and reprofile cylinder fins. - Level 2

Estimated Instructional Time . . . . . 10.0 hrs.

ENGINE EXHAUST SYSTEMS

15. INSPECT, CHECK, TROUBLESHOOT, SERVICE, AND REPAIR ENGINE EXHAUST SYSTEMS. - Level 3 13.0 hrs.

A. Inspect, remove, replace, adjust, and repair joints in the exhaust system. - Level 3

B. Inspect, remove and reinstall exhaust heaters. - Level 3

C. Identify, inspect and describe the operation of turbo-superchargers and turbocompound engines. - Level 2

D. Describe the operation and inspection of jet engine thrust reversers and noise suppressors. - Level 2

16. REPAIR ENGINE EXHAUST SYSTEM COMPONENTS. - Level 2 4.0 hrs.

A. Recognize materials used in exhaust system components and describe repair procedures. - Level 2

Estimated Instructional Time . . . . . 17.0 hrs.

IGNITION SYSTEMS

17. OVERHAUL MAGNETO AND IGNITION HARNESS. - Level 2 30.0 hrs.

A. Disassemble, identify components, and reassemble a magneto. - Level 2

B. Inspect and select serviceable magneto breaker assembles. - Level 2

C. Internally time a magneto. - Level 2

D. Install high tension leads. - Level 2

E. Assemble, operate and disassemble an impulse coupling on a magneto. - Level 2

18. INSPECT, CHECK, SERVICE, TROUBLESHOOT, AND REPAIR RECIPROCATING AND TURBINE ENGINE IGNITION SYSTEMS. - Level 3 32.0 hrs.

A. Inspect, check, troubleshoot, remove and reinstall wiring to an ignition switch. - Level 3

B. Use an ignition harness tester to identify a shorted ignition lead on an engine. - Level 3

C. Install, inspect, operate, troubleshoot and repair an ignition booster system. - Level 3

D. Remove, inspect, recondition, test and reinstall spark plugs. - Level 3

E. Time magnetos to an engine. - Level 3

F. Identify, compare and interpret ignition analyzer patterns. - Level 2

G. Compare and describe the differences between piston engine and turbine engine ignition systems. - Level 2

19. REPAIR ENGINE IGNITION SYSTEM COMPONENTS. - Level 2 28.0 hrs.

A. Operate and test a magneto on a test bench. - Level 2

B. Test and judge the serviceability of condensers. - Level 2

C. Use a coil tester to test ignition coils. - Level 2

D. Demonstrate the effect of faults in an ignition lead and correct the fault. - Level 2

Estimated Instructional Time . . . . . 90.0 hrs.

ENGINE ELECTRICAL SYSTEMS

20. INSTALL, CHECK, AND SERVICE ENGINE ELECTRICAL WIRING, CONTROLS, SWITCHES, INDICATORS, AND PROTECTIVE DEVICES. - Level 3 38.0 hrs.

A. Types, purposes, applicability and operation of electrical fuses, circuit breakers, and switches. - Level 1

B. Select and install aircraft electrical switches and wiring to engine electrical components. - Level 3

C. Installation requirements and characteristics for aircraft electrical wiring systems and junction boxes. - Level 1

D. Install electrical terminals, splices and bonding jumpers, and identify aircraft electrical cables. - Level 3

E. Use of quick-disconnect electrical connectors and characteristics of high- and low-tension electrical wire. - Level 1

F. Install and wire solenoid operated switches, determine causes and effects of solenoid switch chatter. - Level 2

21. REPAIR ENGINE ELECTRICAL SYSTEM COMPONENTS. - Level 2 19.5 hrs.

A. Use service manuals and parts catalogs to locate procedures for repair or replacement of engine electrical system components and to obtain part numbers for replacement parts. - Level 2

B. Check, troubleshoot and repair an aircraft dual DC generator electrical system. - Level 2

C. Determination of approximate, actual, and permissible continuous load on an aircraft electrical generating system. - Level 2

D. Inspect, check, and repair solenoid operated valves for engine pneumatic functions. - Level 2

Estimated Instructional Time . . . . . 57.5 hrs.

ENGINE INSTRUMENT SYSTEMS

22. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE TEMPERATURE, PRESSURE, AND RPM INDICATING SYSTEMS. - Level 3 18.0 hrs.

    A. Operating principles and installation practices of temperature indicating systems for aircraft engine instrumentation. - Level 1

    B. Check, troubleshoot and repair thermocouple and resistance/ratiometer temperature indicating systems. - Level 3

    C. Purpose, operating principles and troubleshooting of manifold pressure indicating systems. - Level 1

    D. Inspect, check, troubleshoot and repair engine tachometer systems. - Level 3

    E. Purposes, operating principles, requirements and applications of engine inlet and outlet temperature indicating systems. - Level 1

    F. Purposes, operating principles and applications of pressure indicating and warning systems used with aircraft engines. - Level 1

23. TROUBLESHOOT, SERVICE AND REPAIR FLUID RATE OF FLOW INDICATING SYSTEMS. - Level 2 2.5 hrs.

    A. Troubleshoot and service. - Level 2

Estimated Instructional Time . . . . . 20.5 hrs.

ENGINE FIRE PROTECTION SYSTEMS

24. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE FIRE DETECTION AND EXTINGUISHING SYSTEMS. - Level 3 5.0 hrs.

    A. Inspect, check, troubleshoot and repair engine fire detection systems. - Level 3

    B. Inspect, check, service, troubleshoot and repair engine fire extinguishing systems. - Level 3

Estimated Instructional Time . . . . . 5.0 hrs.

PROPELLERS

25. INSPECT, CHECK, SERVICE AND REPAIR FIXED-PITCH, CONSTANT-SPEED, AND FEATHERING PROPELLERS, AND PROPELLER GOVERNING SYSTEMS. - Level 3 33.0 hrs.

    A. Identify and describe the forces acting on a propeller. - Level 2

    B. Measure propeller blade pitch angles. - Level 2

    C. Locate and interpret engine-propeller "critical range" information. - Level 2

    D. Locate and interpret "static limit" information for fixed pitch propellers. - Level 2

    E. Describe the operation and control by a counter-weight propeller. - Level 2

F. Describe the operation and control of a hydromatic propeller. - Level 2

G. Describe the operation and control of non-counterweight variable pitch, feathering, and reversing propellers. - Level 2

H. Describe the operation and control of a turbine engine propeller system. - Level 2

I. Inspect and identify probable location of defects in the metal tipping of propellers. - Level 2

J. Smooth nicks, cuts, and scratches in the leading and trailing edges of metal propeller blades. - Level 3

26. INSTALL, TROUBLESHOOT AND REMOVE PROPELLERS. - Level 3 20.5 hrs.

A. Check operation of a full feathering and reversing propeller. - Level 3

B. Remove and install a propeller on a tapered shaft. - Level 3

C. Remove and install a propeller on a splined shaft. - Level 3

D. Check track of a propeller. - Level 3

E. Externally adjust and rig a propeller governor. - Level 3

F. Troubleshoot descriptions of faults in a hydromatic propeller. - Level 3

27. INSPECT, CHECK, SERVICE AND REPAIR PROPELLER SYNCHRONIZING AND ICE CONTROL SYSTEMS. - Level 1 8.0 hrs.

A. Identify components and describe the operation of propeller anti-icing systems. - Level 1

B. Locate reference information and describe the operation of propeller synchronizing systems. - Level 1

28. IDENTIFY AND SELECT PROPELLER LUBRICANTS. - Level 2 2.0 hrs.

A. Identify the lubricant to be used to service a specific propeller. - Level 2

29. BALANCE PROPELLERS. - Level 2 6.5 hrs.

A. Interpret information and describe the procedure for balancing fixed pitch and variable pitch propellers. - Level 2

30. REPAIR PROPELLER CONTROL SYSTEM COMPONENTS. - Level 2 8.0 hrs.

A. Describe the action of a propeller governor and the forces which control propeller pitch. - Level 2

B. Perform the operation necessary to match direction of governor rotation to the rotation of the engine drive. - Level 2

Estimated Instructional Time . . . . . 78.0 hrs.

Total Estimated Instructional Time . . . . . 437.0 hrs.

Additional Practice and/or Examinations . . . . . 10.0 hrs.

Grand Total for Powerplant Curriculum
("Theory and Maintenance" and "Systems and Components") . . .750.0 hrs.

LUBRICATION SYSTEMS

1. IDENTIFY AND SELECT LUBRICANTS. (EIT = 10½ hrs., T = 5 hrs., L/S = 5½ hrs.) 3 segments

(UNIT LEVEL 2)

IDENTIFY CHARACTERISTICS OF LUBRICANTS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  A matching type ten question examination identifying lubricants. The content of the examination will refer to base type, film strength, viscosity index and flashpoint of lubricating oils.

- **Performance:**
  The student will match the characteristics to the various types of lubricants.

- **Standard:**
  The student will correctly associate seven of the characteristics of lubricating oils with the base type of lubricant.

Key Points	*Feedback*
Types of lubricants.	• Why is a mineral lubricant more satisfactory than vegetable or animal lubricants? • Why were synthetic lubricants developed? • What precaution should be observed when converting from mineral lubricants to the synthetic type lubricating oils?
Properties of lubricants.	• What effect would a low flashpoint lubricant have upon the operation of a piston engine? • How do climatic conditions influence the selection of lubricating oils? • What comparison may be made between an SAE viscosity and an "Aero grade" viscosity index? • What is the pour point of a lubricating oil? • What is the advantage of multi-viscosity lubricant? • Why is it important that a designated lubricant be used?

IDENTIFY THE SECONDARY FUNCTIONS OF LUBRICATING OILS.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- **Given:**
  A list of twenty statements which identify the functions of a lubricating oil.

- **Performance:**
  The student will identify those statements associated with the cooling, sealing and cleaning of an engine.

- **Standard:**
  The student will correctly identify five statements related to each of 3 secondary functions of the lubricating oil.

Key Points	*Feedback*
Cooling.	• How is heat transferred from the piston to cylinder walls of a piston engine? • How is the heat contained in the oil dissipated?
Sealing.	• How does the action of the lubricating oil prevent the loss of compression past the piston rings?
Cleaning.	• How is sludge carried to the sumps and sump chambers of an engine? • What keeps the internal parts of an engine free of rust?

RECOGNIZE AND IDENTIFY ACCEPTABLE LUBRICANTS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Containers (oil cans) for a variety of aircraft lubricants, i.e., compounded, detergent, dispersant, etc., and the aircraft/engine service manuals for at least three different models of airplanes and engines.

- **Performance:**
For three different models of airplanes and engines the student will: recognize the containers and identify the type of lubricant; locate appropriate information in the manuals specifying the type of lubricant recommended for the specific engine; and explain the general precautions to be observed when adding oil (or changing oil) and the probable results or damage which may result when various grades, or incorrect types of lubricants are used.

- **Standard:**
The student will identify the lubricants, interpret the manuals and explain the procedures without error.

Key Points	*Feedback*
Source of information recommending correct lubricant.	•Where would a mechanic locate data which would assist in determining the correct lubricant for a specific engine? •What is the effect of climatic temperatures on the selection of oils? •What grade of aviation oil has the same viscosity as SAE 50? •Why are some engines operated on a synthetic lubricating oil? •Why will the manufacturer's manual probably specify a higher viscosity oil for those airplanes which operate in tropical climates?
Additives and mixing of lubricating oils.	•What effect does a detergent lubricant have on an engine? •Should additives be used when oil consumption of the engine is excessive? •Why should detergent oil *not* be used in an engine which has been using nondetergent oil? •What action would a mechanic take if he inadvertently added one quart of nondetergent oil to an engine that has been operating on a compounded oil?

Activities	*Check Items*
	Did the student:
Identify oil containers.	•Identify various lubricants by reference to the container labels?
Interpret service manuals for three different models of airplanes and engines.	•Determine the recommended lubricant by reference to manuals?
Explain precautions relative to mixing of lubricants.	•Demonstrate an awareness for the hazards?

2. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE LUBRICATION SYSTEMS.

(EIT = 40.5 hrs., T = 22 hrs., L/S = 18.5 hrs.)
12 segments

(UNIT LEVEL 3)

DIAGRAM AND EXPLAIN THE OPERATION OF WET AND DRY SUMP LUBRICATION SYSTEMS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
Schematic diagrams of both wet and dry sump lubrication systems and appropriate reference information.

- **Performance:**
The student will explain the principles and indicate by arrows on the diagrams the oil flow through both types of lubrication systems.

- **Standard:**
Explanations and indication of oil flow will be in accordance with the reference information.

Key Points	*Feedback*
Types of lubrication systems.	•What are some advantages of a wet sump oil system? •What system is used on radial engines? •How many oil pumps do each of the systems incorporate?
Venting of dry sump systems.	•Why is the oil tank often vented to the engine crankcase? •Under what conditions may the oil tank vent freeze? Where does the moisture in the tank vent originate? •What methods have been developed to minimize icing of engine breather vents?
Venting of wet sump systems.	•Why must a wet sump crankcase be vented? •Describe a method that will minimize icing of a crankcase vent system.

Activities	*Check Items*
	Did the student:
Draw arrows on diagrams to indicate oil flow.	• Correctly illustrate the direction of oil flow in both systems?
Explain the principles of operation of both wet and dry sump systems.	• Use correct nomenclature as a part of the explanations?

CHANGE OIL, CHECK SCREENS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An operating aircraft engine, a quantity of aircraft lubricating oil, appropriate tools, equipment and reference information.

- Performance:
  The student will drain oil, clean and inspect the screens, safety the drain plugs and refill the system with lubricating oil. He will explain the reasons for changing oil at the specified intervals and the significance of metallic particles found in screens and filters.

- Standard:
  All procedures and standards of performance will be in accordance with the manufacturer's service instructions.

Key Points	*Feedback*
Oil change intervals.	• Why should the oil in an aircraft engine be changed? • Where would the recommended time interval between oil changes be published? • Why do local operating conditions often dictate a modification of the recommended time between oil changes?
Procedure for oil changes.	• Why should the oil be warm before draining? • What causes deformation of the brass oil screen nuts? • What corrective actions are necessary if the capillary line is broken on the oil temperature bulb during an oil change?
Inspection of oil screens.	• How would a mechanic check an oil filter or oil screen for metallic particles? • What are some sources of aluminum particles found in an oil screen? • When could a mechanic expect to find some particles of metal in an oil screen? • How can metal or nonmetal particles found in an oil system be identified? • How is an oil screen cleaned?
Safetying of drains, screens and refilling with oil.	• How many times may a crush washer be re-used? • What precautions should be taken to ensure correct torque of drain plugs, filters, etc.? • What publication should a mechanic refer to in order to determine the quantity and viscosity of lubricating oil for an engine?

Activities	*Check Items*
	Did the student:
Drain oil, clean and inspect oil screens and filters.	• Follow the correct procedures?
Safety plugs, screens, filters, and refill with oil.	• Maintain return-to-service standards? • Observe safety precautions while accomplishing the tasks?
Explain reasons for oil changes and significance of metal in the screens.	• Use correct nomenclature as a part of the explanations?

SERVICE AN OIL BY-PASS VALVE.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  A lubrication system (installed in an airplane or mock-up) incorporating a by-pass valve as a part of an oil cooler or oil filter and the service instructions for the lubrication system.

- Performance:
  The student will interpret the service instructions, physically locate the by-pass valves in the system. He will disassemble one by-pass valve, explain the operation of the valve and reassemble the valve into the component or system.

- **Standard:**
The task will be accomplished in accordance with the service instructions. Correct nomenclature will be used throughout the explanation. The reassembled valve will operate normally.

Key Points	*Feedback*
Location of by-pass valves.	• Why is a by-pass valve often located on the inlet side of an oil cooler? • Why is a by-pass valve necessary in an oil filter?
Purpose and operation.	• When is the oil cooler by-pass valve in the open position? • When is an oil filter by-pass valve in the closed position? • What operating difficulties may result from a by-pass valve in an oil cooler sticking in the open position? • What damage could result if the by-pass valve in an oil screen stuck in the open position?
Disassembly and reassembly procedure.	• What publication will specify the correct assembly and disassembly procedures? • Explain why by-pass valves are not adjustable.

Activities	*Check Items* Did the student:
Locate the by-pass valves within the system. Disassemble and reassemble the by-pass valve. Explain operation of the valve.	• Use appropriate reference manuals? • Follow correct procedures? • Exercise care in handling tools and components? • Use correct nomenclature as part of the explanation?

SERVICE DISC TYPE OIL FILTERS AND EXPLAIN THE FUNCTION OF CRANKSHAFT SLUDGE CHAMBERS.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
A stacked disc, edge filtration type oil filter; a crankshaft incorporating sludge chambers and appropriate reference information.

- **Performance:**
The student will disassemble, inspect and reassemble the oil filter. He will identify the sludge chambers in the crankshaft and explain the purpose of such chambers. He will interpret the service instructions pertaining to the removal, cleaning and reinstallation of disc type filters.

- **Standard:**
Service work will be performed at a return-to-service standard. Explanations will be in accordance with the service information.

Key Points	*Feedback*
Types of disc filters.	• How does a manual type filter differ from an automatic or hydraulic type cuno?
Operation.	• At what time interval should the handle of a manual type filter be rotated? • What is the purpose of the wiper blades in a disc filter? • How is the oil flow of the hydraulic or automatic filter utilized to rotate the discs?
Service and inspection.	• How often should a cuno filter be cleaned? • Where is the disassembly and reassembly procedure published?
Crankshaft sludge chambers.	• What procedures have been developed to minimize sludge accumulation in a crankshaft? • What causes the sludge to accumulate in a crankshaft?
Cleaning sludge chambers.	• How are crankshaft sludge chambers cleaned? • What damage may result from failure to clean the sludge chambers at engine overhaul?

Activities	*Check Items* Did the student:
Disassemble and reassemble a stacked disc type oil filter. Identify crankshaft sludge chambers and explain purpose.	• Follow correct procedures and exercise care in handling tools and components? • Use correct nomenclature as a part of the explanation?

DESCRIBE PURPOSE OF OIL PRESSURE GAUGE LINE RESTRICTORS.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:
  A diagram of an oil pressure gauge mechanism and gauge line, a direct reading oil pressure gauge and appropriate reference information.
- Performance:
  The student will label the diagram and explain the purpose of the restricted orifice in the gauge line and physically identify the orifice in the instrument.
- Standard:
  The student will correctly interpret the reference information and use correct terminology and nomenclature as part of the explanation.

Key Points	*Feedback*
Purpose of a restrictor.	• Where is the restricting orifice located in the oil pressure gauge system? • Explain how a restrictor serves to damp pressure surges and prevent damage to the oil pressure gauge mechanism. • What visible indications would exist if the Bourdon tube of an oil pressure gauge ruptured?
Principles of operation.	• How does a Bourdon tube react to internal pressures? • How would a Bourdon tube react to external pressures?

Activities	*Check Items* Did the student:
Label the diagram of an oil pressure gauge system. Explain the purpose of a restrictor. Identify a restrictor in the gauge or in the system.	• Use correct nomenclature to label the diagram and explain the purpose of a restrictor? • Point to the location of the restrictor in the actual instrument?

IDENTIFY COMPONENTS OF AN OIL SCAVENGING SYSTEM AND DESCRIBE OPERATION OF THE SYSTEM AND TROUBLESHOOT.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  A diagram or line drawing of the oil scavenging system: components of the scavenging system, appropriate reference information, ten written statements describing faulty operation of an oil system.
- Performance:
  The student will label the diagram, naming each component from a display of parts and describe the operation of a scavenging system, and identify conditions that are caused by failure of the scavenging system.
- Standard:
  The components will be identified and named without error. The description of operation will be in accordance with the manufacturer's manual and will include use of correct nomenclature. From the description of faulty operation of an oil system, the student will identify five conditions that could be caused by failures of the scavenging system.

Key Points	*Feedback*
Components of the scavenging system.	• Where is the drain sump of an oil system located? • Why are the intercylinder oil drain lines generally considered a part of the scavenging system? • Why do some radial engines have external oil lines from one section of the engine to another? • Why is the capacity of the scavenge pump greater than the capacity of the oil pressure supply pump? • Why do some sump drain plugs have magnets?
Description of system operation.	• What reference publications would contain information describing the scavenging system?
Troubleshooting.	• How would an obstructed intercylinder drain line affect the scavenging system? • What inflight symptoms would indicate a crack in the line between the pump and the oil supply tank? • What procedure should be followed to prime an oil pump? • What evidence would probably indicate a leak in an external oil line?

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Activities	*Check Items*
	Did the student:
Label the diagram of a scavenging system.	•Correctly use and interpret information from the manuals?
Identify components and describe operation of the system.	•Use correct nomenclature?
Select five statements that could be associated with failure of the scavenging system.	•Make correct judgment of the written statements?

INTERPRET FAA REGULATIONS PERTAINING TO OIL SUPPLY TANKS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- Given:
  Appropriate section of the Federal Air Regulations and the manufacturer's manuals for at least two twin engine airplanes; a line drawing of an oil supply tank incorporating a hopper.
- Performance:
  The student will locate and interpret the FAA regulations which govern expansion space requirements and the marking of oil tank filler openings. Using the diagram or drawing of an oil supply tank, he will describe the methods commonly employed to maintain a reserve supply of oil for propeller feathering.
- Standard:
  The student will locate and interpret the regulations without error.

Key Points	*Feedback*
Minimum expansion space requirements.	•Why is an oil tank larger than the placarded capacity of the tank? •What is the simplest method of determining the capacity of an oil tank?
Filler opening markings.	•Why is an oil cap usually painted yellow? •Why don't the regulations require the oil cap placard to indicate the viscosity and type of oil? •How may the design of an oil tank preclude overfilling? •How can the oil quantity in an oil tank be verified?
Design features.	•What is a "hopper" in an oil tank? •Why is a special feathering supply of oil usually required in multi-engine airplanes? •Why are some tanks vented to the engine breather? •When are in-flight oil quantity gauges required?

Activities	*Check Items*
	Did the student:
Locate and interpret FAA regulations pertaining to oil supply tanks.	•Correctly locate and interpret regulations?
Use correct nomenclature to label a diagram of an oil supply tank.	•Apply information obtained from the manuals and use correct nomenclature as a part of the description of operation?

EXPLAIN THE PURPOSE AND DESCRIBE THE OPERATION OF AN OIL DILUTION SYSTEM.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  Service manuals and a line diagram or drawing of an oil dilution system.
- Performance:
  The student will label the diagram and explain the purpose of an oil dilution system. He will describe the sequence of operation or procedure applicable to a specified model of engine or airplane.
- Standard:
  The procedure described will be in accordance with the manufacturer's manual. Correct nomenclature will be used to label the diagram and as a part of the description and explanation.

Key Points	*Feedback*
Purpose of oil dilution.	•Why are engines hard to start in cold weather? •How may a mechanic "thin-out" or reduce the viscosity of oil during cold weather operation? •How does the addition of gasoline to oil affect the viscosity of oil?

	• What device or component of the oil dilution system actually introduces the gasoline into the oil system?
Oil dilution procedure.	• When is the oil normally diluted? • What determines the amount of dilution? • What will result from over-dilution of the oil? • What indications are available in the cockpit to indicate that normal operation of the dilution valve is taking place? • How is the fuel eventually eliminated from the lubricating oil?

Activities	*Check Items* Did the student:
Label the oil dilution diagram. Locate and interpret information from the manuals. Describe sequence of operation of an oil dilution system.	• Use correct nomenclature? • Correctly describe sequence? • Describe the hazards associated with deviations from normal procedure?

ADJUST OIL PRESSURE ON AN OPERABLE ENGINE.

(SEGMENT I. LEVEL 2)

Student Performance Goal

- Given:
  An operable aircraft engine and the manufacturer's service manual.

- Performance:
  The student will adjust the oil pressure.

- Standard:
  The student will follow the correct procedure and achieve an adjusted pressure within the operating range specified in the manual.

Key Points	*Feedback*
Adjusting oil pressure on an engine.	• Why is it important that the correct oil pressure be maintained in an engine? • What will be the effect of placing a washer under the spring of the oil pressure relief valve? • Why is the indicated oil pressure above normal operating pressure when the engine is first started? • Why are some engines designed without a provision for oil pressure adjustment? • What is the difference between a single spring and a compensated relief valve? • How does oil viscosity affect engine oil pressure? • Where may the oil pressure relief valve be located on an aircraft engine? • What methods of safetying may be used following adjustment of the relief valve?

Activities	*Check Items* Did the student:
Adjust the oil pressure on an operable engine.	• Follow the procedure specified in the manual? • Observe safety precautions? • Achieve an adjustment within the specified limits?

INTERPRET INSTRUMENT INDICATIONS.

(SEGMENT J, LEVEL 2)

Student Performance Goal

- Given:
  Five statements describing instrument indications of operating trouble symptoms within the lubrication system and the manufacturer's manuals for a specific engine.

- Performance:
  The student will interpret the described instrument indications and determine the probable cause of the trouble symptoms or probable defect and explain the reason for his decision.

- Standard:
  Correctly identify the cause or defect in four of the five descriptions of operational trouble symptoms.

Key Points	*Feedback*
Normal indications of oil pressures.	• What will result if oil pressure is lost during flight? • If oil of lower viscosity is added, how would the oil pressure indications be affected? • How does the oil pressure indication react to an increase in oil temperature? • How would oil pressure indications be affected by a break in the oil pressure gauge line? • How does cold, congealed oil in the gauge line effect the indicated oil pressure? • What servicing procedure is employed to minimize the lag in oil pressure indication? • Why may a restricting orifice be incorporated within an oil pressure indicating system?
Interpreting oil pressure indications.	• What oil pressure indications give evidence of a low oil supply? • What faults are associated with a fluctuating oil pressure? • If the oil pressure indication is very slow to respond following starting of the engine, what faults are most probable? • What oil pressure indications are associated with a clogged oil cooler?

Activities	*Check Items* Did the student:
Identify the probable cause of trouble symptoms or defect. Explain the reason for selecting the cause.	• Correctly interpret manufacturer's manuals as an aid in troubleshooting? • Accurately interpret the description of the operating condition and make a logical analysis? • Use correct nomenclature when describing the defect and probable cause?

DESCRIBE THE LUBRICATION OF A VALVE MECHANISM.

(SEGMENT K, LEVEL 2)

Student Performance Goal

- Given:
  A line drawing of an overhead valve mechanism and the manufacturer's service or overhaul manual.

- Performance:
  The student will interpret information from the manual, label the diagram to illustrate oil flow and describe the lubrication of the valve mechanism.

- Standard:
  Components of the valve mechanism will be correctly identified and the drawing will be labeled to illustrate direction of oil flow. Correct nomenclature will be used as part of all descriptions.

Key Points	*Feedback*
Direction of oil flow through a valve mechanism.	• What component of the engine is the source of oil pressure and oil flow? • How is oil under pressure fed to the crankshaft and cam shaft? • If the engine incorporates hydraulic valve lifters, how is oil supplied to these lifters? • If the design of the engine provides for a solid cam follower, how is oil directed to the push rod? • How is oil normally supplied to the rocker arm assembly? • How is lubricating oil supplied to the valve guides? • How does the oil which has lubricated the valve mechanism return to the oil sump?

Activities	*Check Items* Did the student:
Label the components of a valve mechanism and illustrate direction of oil flow. Describe the lubrication of a valve mechanism.	• Use correct nomenclature when labeling the drawing? • Correctly interpret information from the manual?

INSTALL RINGS ON A PISTON AND DESCRIBE THE FACTORS EFFECTING OIL CONSUMPTION IN A PISTON ENGINE.

(SEGMENT L, LEVEL 3)

Student Performance Goal

- Given:
  A piston, set of rings, the manufacturer's manual, a twenty question multiple choice examination pertaining to oil comsumption in a piston engine, ring installation tools.

- Performance:
  The student will install a set of rings on the piston. He will answer the questions relating to the control of oil on the cylinder wall and the effect of engine wear on the operation of the lubrication system and oil consumption of the engine.

- Standard:
  Rings will be installed on the piston in accordance with the instructions contained in the manufacturer's manual. The student will correctly answer 15 of the 20 examination questions.

Key Points	*Feedback*
Oil control piston rings.	•Why do oil control rings often have a bevel on one edge of the ring? •What would be the effect of installing an oil control ring upside down? •What is the difference between an oil wiper and an oil scraper ring? •What materials are used in the construction of piston rings? •How can the position of ring gaps effect oil consumption of the engine? •What are some of the factors to be considered when installing chrome rings in a cylinder? •How is the tension of a piston ring measured?
Oil control at valve guides.	•How would a worn valve guide effect oil consumption of an engine? •How may a worn rocker arm bearing contribute to the oil consumption of an engine?
Oil consumption due to general wear of the engine.	•How do worn connecting rod and main bearings result in increased oil consumption? •How do the increasing clearances throughout an engine due to wear affect oil consumption?

Activities	*Check Items* Did the student:
Install the rings on a piston.	•Follow the procedure specified in the manual? •Work safely and observe precautions to avoid damaging the tools and equipment?
Describe the factors effecting oil consumption of the engine.	•Use correct nomenclature? •Correctly interpret information from the manual? •Correctly answer 15 of the multiple choice examination questions?

3. REPAIR ENGINE LUBRICATION SYSTEM COMPONENTS. (EIT = 18 hrs., T = 11 hrs., L/S = 7 hrs.) 4 segments

(UNIT LEVEL 2)

INSPECT, REMOVE, CLEAN AND REINSTALL OIL LINES.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  An operable engine incorporating a dry sump oil system, the applicable manufacturer's service manuals, appropriate Federal Aviation Regulations, and 10 statements describing size, condition and repair of oil lines.

- Performance:
  The student will locate and interpret the FAA regulations governing the size of oil lines. He will inspect oil lines and remove, clean and reinstall one section of line in the oil system. He will select statements from the list describing size, condition and acceptable repair of oil lines.

- Standard:
  The student will select 8 correct statements from the list. The removal, cleaning and reinstallation of the oil line will be accomplished at return-to-service standards.

Key Points	*Feedback*
Federal Aviation Regulations governing oil lines.	• What determines the size of an oil line for an aircraft engine?

	- What dictates the minimum diameter of an oil return line in a dry sump lubrication system? - What are the FAA requirements for an oil drain in the system?
Inspection, cleaning and replacement of oil lines.	- What method is used for cleaning aluminum alloy external oil lines? - In what section of the oil-lines are cracks most likely to occur? - Describe some of the reasons for rejecting an aluminum oil line. - Why should the alignment of oil lines not be forced by the action of the connecting hoses or fittings? - What considerations govern the use of beaded tubing, flexible hose and hose clamps as connections in the oil systems of aircraft engines?

Activities	*Check Items*
	Did the student:
Remove, clean, reinstall and inspect an oil line.	- Follow the correct procedure? - Accomplish the task with proper regard for personal safety? - Correctly inspect and identify defects in the oil lines? - Reinstall the line with correct torque and adequate support?

IDENTIFY AND DESCRIBE OIL TEMPERATURE REGULATION.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  An oil cooler assembly incorporating a viscosity valve or thermostatic valve and a pressure relief valve, an appropriate diagram of the oil cooler, and reference information and ten statements pertaining to oil temperature regulation.

- Performance:
  The student will label the oil cooler diagram, identifying the components of the assembly. He will draw arrows to indicate the oil flow path during both low and high oil temperature conditions. He will point to both the thermostatic and by-pass element on the oil cooler and when provided with ten statements describing the operation of the oil temperature regulating system, he will select those statements that are related to the operation of the oil cooler.

- Standard:
  The student will correctly label components of the oil cooler in the diagram. He will organize those statements that are related to normal and abnormal operation of the oil cooler.

Key Points	*Feedback*
Oil cooler operation.	- Why isn't all of the oil in the system constantly circulated through the oil cooler? - What will result if the temperature regulator unit fails to seat? - Where is the oil temperature regulator normally positioned in the system? - Why do oil coolers usually have a by-pass valve? - What is a "non-congealing" type of oil cooler? - Under what conditions does the oil flow by-pass the core of the oil cooler? - Why isn't an oil cooler required on every engine?

Activities	*Check Items*
	Did the student:
Draw arrows to indicate flow through an oil cooler.	- Correctly illustrate flow paths?
Label the components of an oil cooler. Point to the thermostatic and by-pass valve on the cooler.	- Correctly identify components on an oil cooler and label the diagram?
Select statements on the list that are related to the operation of the cooler.	- Correctly select all statements?

EXPLAIN THE PROCEDURE FOR CLEANING AND TESTING OIL TANKS.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- Given:
  Twenty written statements correctly or incorrectly describing the cleaning and testing of oil supply tanks, manufacturer's service information and the appropriate Federal Aviation Regulations.
- Performance:
  The student will interpret information from the manuals and regulations concerning the cleaning and testing of oil supply tanks. From twenty written statements describing procedures that might be used, the student will identify the correct statements.
- Standard:
  The student will select all correct statements.

Key Points	*Feedback*
Cleaning procedures.	• What solvents are commonly used to internally clean an oil supply tank? • How are the solvents applied to ensure adequate cleaning of the tank interior?
Testing of oil tanks.	• What publications would most probably indicate the test pressure to be applied to an oil tank? • What would probably happen if excessive test pressures were applied to a tank? • What safety precautions should be observed while cleaning and testing oil tanks?

DISASSEMBLE AND REASSEMBLE AN ENGINE OIL PUMP.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  An engine oil pump from an aircraft engine and the manufacturer's service information.
- Performance:
  The student will disassemble the pump, identify the component parts and reassemble the pump.
- Standard:
  The reassembled pump will be in such condition that it could be operated on the engine. The disassembly and reassembly will be in accordance with the manufacturer's service information.

Key Points	*Feedback*
Oil pumps.	• Why does the engine oil supply pump have less capacity than the scavenging pump? • What path does the oil follow in a gear type pump? • How are the side clearances checked on an oil pump? • What repairs are possible if the pump cavity is scored? • If an oil pump drive gear is scored or nicked, what repairs are permitted?

Activities	*Check Items*
	Did the student:
Disassemble, reassemble an oil pump.	• Follow the procedures described in the manual? • Properly identify parts of the pump and use correct nomenclature as a part of the description of operation. • Exercise care for components and tools during the disassembly and reassembly operations?

4. INSPECT CHECK, SERVICE, TROUBLESHOOT, AND REPAIR ENGINE FUEL SYSTEMS.

(EIT = 5 hrs., T = 2 hrs., L/S = 3 hrs.)
2 segments

(UNIT LEVEL 3)

INTERPRET FEDERAL AVIATION REGULATIONS GOVERNING FUEL SYSTEMS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Copies of the applicable Federal Aviation Regulations, manufacturer's service manual and specifications for the fuel system of a particular airplane.

- Performance:
  The student will locate and interpret information from the reference publications and describe how the regulations govern the strainers, lines, vents, expansion space and sumps of the specific fuel system.

- Standard:
  The reference information will be interpreted without error. Correct terminology and nomenclature will be used as a part of the description.

Key Points	*Feedback*
Finger strainers.	• What is the size of wire screen mesh used in finger strainers in the fuel system? • What is the ratio of length to diameter of a fuel strainer?
Routing of fuel lines.	• What publication would a mechanic use when determining the routing of a fuel line? • What are the general requirements for supporting and securing fuel lines? • What is the minimum radius of bend in a fuel line? • What is the purpose of bonding fuel lines? How is such bonding accomplished?
Size of fuel lines.	• What is the minimum rate of flow required of fuel lines in an airplane? • What general requirements govern the size of ports and passages in fuel selector valves? • What are the size requirements for flexible fuel hoses and connections within the fuel system?
Vents, expansion space and sumps.	• Why is it necessary to vent the tanks? • Why are the airspaces of two tanks often interconnected? • Why is the filler opening of some fuel tanks positioned so that the tank cannot be completely filled with fuel?

Activities	*Check Items* Did the student:
Interpret the Federal Aviation Regulations governing fuel systems. Compare the fuel system as described in the manufacturer's manual with FAR's.	• Correctly apply and interpret the regulations? • Use correct nomenclature as a part of the description?

INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR AN ENGINE FUEL SYSTEM.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An operational fuel system including a fuel tank, tank outlet strainers, lines, sump drains, selector valves, main fuel strainer and carburetor or fuel injection system, and the manufacturer's service instructions for the specific system.

- Performance:
  The student will inspect, check, service, troubleshoot and repair problems introduced into the system by the instructor.

- Standard:
  The inspection, servicing and repair of the system will be in complete accordance with the service instructions. As a part of the troubleshooting procedure, the student will identify, isolate and correct a simulated problem caused by contamination and vapor lock.

Key Points	*Feedback*
System operation.	•What reference information would a mechanic use to determine the normal operating pressures for a fuel system? •What publication would illustrate the location of firewall shutoff valves, control valves, strainers, etc.? •If the system incorporates centrifugal boost pumps, how could the mechanic determine the procedure for use of these pumps?
Inspection of fuel systems.	•What inspection and servicing is generally necessary with fuel tank sumps and strainers? •Describe the conditions which may lead to contamination of the fuel in the system. •What inspection should a mechanic give to both solid and flexible fuel lines? •How can a mechanic inspect a flare at a fitting?
Servicing fuel systems.	•Describe the conditions that may result in fluctuating fuel pressure. •Where would a mechanic find information that describes the procedure for adjusting the fuel pressures? •What is a vapor lock? What procedure is most effective in eliminating a vapor lock?
Troubleshooting and repairing fuel systems.	•What publications would contain troubleshooting instructions applicable to a particular airplane fuel system? •What precautions should be observed when draining fuel from the system? •If it becomes necessary to disconnect a fuel line, or block and obstruct some portion of the system, what precautions should be taken?

Activities	*Check Items*
	Did the student:
Inspect and service the tank sumps and main fuel strainer.	•Use and correctly interpret information from the service manual?
Adjust fuel pressure.	•Correctly check for leaks following service and repair operations?
Troubleshoot a fuel leak introduced into the system by the instructor.	•Safety all components following service and repair?
Replace a section of rigid or flexible fuel line.	•Verify correct operation following replacement of lines and components?
Remove a section of rigid or flexible fuel line.	
Remove and replace a valve, pump or other component in a system containing fuel.	
Identify, isolate and correct a simulated problem caused by contamination and vapor lock.	

5. REPAIR ENGINE FUEL SYSTEM COMPONENTS.

(EIT = 8½ hrs., T = 3½ hrs., L/S = 5 hrs.)

2 segments

(UNIT LEVEL 2)

DESCRIBE THE OPERATION OF FUEL PUMPS AND REMOVE AND INSTALL A PUMP ON AN ENGINE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  A vane type fuel pump, a diaphragm type fuel pump and the service information applicable to each type of pump.

- Performance:
  The student will interpret the service information, identify the parts of the pumps and describe the operation of fuel pumps. He will remove and reinstall a fuel pump on an engine.

- Standard:
  The description of operation and the removal and reinstallation will be in full accordance with the service instructions. Correct nomenclature and terminology will be used as a part of the description of operation.

Key Points	*Feedback*
Types of engine fuel pumps.	•How does the displacement of a vane type pump compare with the displacement of a diaphragm pump?

	•What information is included on the data plate that is attached to a fuel pump? •What reference publication would a mechanic use to determine the type of pump that was approved for installation on an engine?
Description of operation.	•How does a mechanic determine the direction of rotation for a vane type pump? •What procedure is necessary to change the direction of rotation of a fuel pump? •Why do fuel pumps usually incorporate a relief valve within the pump housing? •Why do some fuel pumps incorporate a vapor separator and a venting system? •Why do some engine driven fuel pumps incorporate a bypass valve?
Identification of features.	•Why do fuel pumps have a shear section in the drive coupling? •How may a mechanic determine whether the pump seal or the accessory drive seal has failed? •How may a mechanic detect a ruptured pump diaphragm? What effect will it have on the pump?

Activities	*Check Items*
	Did the student:
Identify the parts of the pumps and describe the operation.	•Correctly interpret service information and identify: a. The inlet and outlet ports? b. The fuel flow through the relief and bypass valves? c. The shear section? d. The direction of pump rotation?
Remove and reinstall a fuel pump on an engine.	•Follow the procedure and correctly use the tools specified?

DESCRIBE THE OPERATION OF AUXILIARY AND BOOST PUMPS, REMOVE AND INSTALL AN AUXILIARY OR BOOST PUMP IN A SYSTEM.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Fuel system diagrams, the service instructions for one specific type of auxiliary or boost pump and a fuel pump of that type.
- Performance:
  The student will explain the purpose of auxiliary and fuel boost pumps. He will describe the operation of various types of pumps. He will remove and reinstall an auxilliary or boost pump in the fuel system.
- Standard:
  The explanations and descriptions will include use of the correct nomenclature and terminology. The installation and removal of the pump will be in accordance with the service instructions.

Key Points	*Feedback*
Types of auxiliary and fuel boost pumps.	•How is a centrifugal fuel boost pump most generally driven? •Describe the operation of a wobble pump. •Why must a submerged type pump be immersed in liquid when it is checked for operation?
Location of auxiliary and boost pumps.	•Where are boost pumps generally located within a fuel system? •How does a boost pump tend to eliminate vapor from the liquid fuel in the system? •What action within a wobble pump prevents reverse fuel flow within the pump? •Describe the conditions that would make the installation of boost pumps necessary.
Removal and installation procedures.	•Describe how a mechanic should disconnect electrical power to a submerged boost pump prior to removing the pump. •Describe a sequence of operations that would be used to remove a submerged boost pump.

•What reference information would a mechanic use to determine the removal-installation procedures for a specific airplane?

Activities	*Check Items*
	Did the student:
Illustrate by using the fuel system diagram the location of the auxiliary or boost pumps. **Describe the operation of various types of pumps.** **Remove and install an auxiliary or boost pump in a system that contains fuel.**	**•Use and correctly interpret information from the service manual?** **•Use correct nomenclature to describe the location of the pumps?** **•Use correct nomenclature and terminology as a part of the description of operation?** **•Follow the procedures specified in the manual?** **•Observe all safety precautions?**

6. INSPECT, CHECK, SERVICE, TROUBLESHOOT, AND REPAIR RECIPROCATING AND TURBINE ENGINE FUEL METERING SYSTEMS. (EIT = 30 hrs., T = 13 hrs., L/S = 17 hrs.) 9 segments

(UNIT LEVEL 3)

EXPLAIN TEMPERATURE, PRESSURE, AND HUMIDITY EFFECTS ON OPERATION OF A CARBURETOR.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Appropriate reference information (charts, visual aids or manufacturer's manuals) that describes the effect of air density on carburetor operation.

- Performance:
  The student will describe the operation of a carburetor and explain how variations in temperature, pressure and humidity of the air will effect the operation of the engine.

- Standard:
  The student will correctly interpret charts and reference data. He will use correct nomenclature and terminology throughout the descriptions and explanations.

Key Points	*Feedback*
Internal combustion engines.	•Why does an internal combustion engine demand air in order to operate? •What causes air to flow into the engine as the engine is started? •Where is a carburetor or fuel metering device located with respect to the induction manifold of the engine?
Air density.	•Describe how temperature, pressure and water vapor effect the density of air. •As an airplane climbs to higher altitudes, how is the density of the air changing? •How does the application of carburetor heat effect the density of the air entering the engine?
Fuel air ratios.	•If the air density is decreased, what change must occur in the amount of fuel being metered to the engine? •If the fuel air ratio is permitted to become richer or leaner than best power mixture, what will be the effect on engine power available?

Activities	*Check Items* Did the student:
Describe the effect of air density on engine operation.	•Correctly interpret information from the charts, diagrams, and reference manuals? •Use correct terminology and nomenclature?

DESCRIBE THE OPERATION OF A FLOAT CARBURETOR.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  A typical float carburetor incorporating an idle metering system, an accelerating and main discharge system, idle and altitude mixture control systems; appropriate reference information describing the operation and systems of the specific carburetor; an unlabeled line drawing or sketch illustrating the components of the carburetor.

- Performance:
  The student will interpret information contained in the manual, disassemble the carburetor and label the sketch as a means of identifying the components and systems. He will describe the operation of each system, pointing to the passageways of the carburetor, he will trace the flow of fuel and air and describe how it is metered to the engine. He will reassemble the carburetor.

- Standard:
  Information will be correctly interpreted. Correct nomenclature will be used when labelling the drawing and correct terminology and phraseology will be a part of all descriptions and explanations. Disassembly and reassembly will be in accordance with the procedure described in the reference publications.

Key Points	*Feedback*
Combustible fuel-air mixtures.	• Explain why gasoline and other combustible fuels must be varporized in order to burn. • What is the approximate ratio of gasoline to air that provides the most perfect combustion? • What problems are experienced when attempting to operate a piston engine at air-fuel ratios that are overly rich? • What problems are associated with operation at air-fuel ratios that are overly lean?
Idle metering system.	• How is the float level changed in a float type carburetor? • How are fuel-air ratios related to float level of the carburetor? • At what position in the carburetor is fuel discharged from the idle metering system? • What is the function of an idle air bleed? • How is the idle mixture of a float carburetor adjusted?
Main metering system.	• At approximately what engine RPM does the carburetor transition from the idle metering system into the main discharge system? • Why doesn't fuel discharge from the main discharge nozzle when the throttle is in the idle speed range? • What is the relative position of the main discharge nozzle with respect to the level of fuel in the float chamber? • Where is a main metering jet located within a float carburetor?
Accelerating system.	• What is the purpose of an accelerating system in a carburetor? • What engine operating fault would indicate a problem in the accelerating system? • What reference publications are available to a mechanic as an aid to troubleshooting a suspected carburetor malfunction?
Economizing or power-enrichment systems.	• Why do some carburetors incorporate devices which enrich the mixture supplied to the engine at high power output? • Describe some of the systems that have been developed to provide power enrichment? Why is such a system also referred to as an "economizer" system?
Altitude mixture control.	• Why is it necessary to control the fuel-air mixtures at altitude? • Describe how the fuel mixtures are regulated by the various types of altitude mixture controls. How does a "back-suction" control operate? • Explain how some mixture control systems may provide for "idle cut-off" of the engine.

Activities	*Check Items*
	Did the student:
Disassemble the carburetor and label the drawing identifying components and systems.	• Correctly interpret information from the manual and label the drawing? • Follow correct disassembly procedure and use specified tools?
Describe the operation of the carburetor and reassemble.	• Use correct nomenclature and terminology as a part of the description and explanation? • Completely and correctly reassemble and safety the carburetor.

IDENTIFY A PRESSURE TYPE CARBURETOR AND A DIRECT FUEL INJECTION SYSTEM AND DESCRIBE THE OPERATION OF EACH SYSTEM.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A typical pressure carburetor; the components of a direct cylinder fuel injection system; appropriate reference information describing the operation of each system; line drawings, schematics or diagrams of the systems.

- **Performance:**
  The student will point to the component or carburetor and name the part. He will interpret information from the reference publications and describe the operation of both systems. He will compare the advantages and limitations of the two systems.

- **Standard:**
  Components will be correctly identified by name. Correct nomenclature and terminology will be used throughout the description of operation.

Key Points	*Feedback*
Pressure carburetors.	• What systems are incorporated into a pressure carburetor? • What forces are employed to move the diaphragms and meter fuel through the carburetor? • Where is the fuel metered by a pressure carburetor introduced into the intake manifold? • What field adjustments may *be made on a pressure* carburetor by a mechanic?
Master control direct fuel injection systems.	• How is a master control similar to a pressure carburetor? • What other components, in addition to the master control, are necessary to the operation of a direct fuel injection system? • What field adjustments are permitted on a direct fuel injection system? • What is the purpose of synchronizing blocks?
Direct fuel injection nozzles.	• How are spray patterns determined? • How are nozzles and piping pressure tested? • What ways can be used in locating a defective nozzle?
Pressure injection nozzle.	• How is the discharge nozzle checked for proper opening pressure? • What is the opening pressure range? • How does an impeller that creeps forward affect the discharge of fuel in some radial engines?

Activities	*Check Items*
	Did the student:
Identify and distinguish between a pressure carburetor and and components of a direct fuel injection system. Describe operation of each system, comparing advantages and limitations of each.	• Correctly identify the components? • Use correct nomenclature and terminology as a part of all descriptions, explanations and identification?

EXPLAIN THE FUNCTION OF VAPOR SEPARATORS AND VAPOR VENTS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Diagrams, schematics or written information describing the purpose and function of vapor separators and vapor vents; unlabeled line drawings or sketches of the vapor return system of a specific model of airplane and the manufacturer's manual for that airplane.

- **Performance:**
  The student will explain the function of vapor separators and vapor vents as incorporated into a pressure carburetor of a fuel injection system. He will label the drawing as a means of identifying the components and operation of the system.

- **Standard:**
  The drawing will be correctly labeled. Correct nomenclature will be used throughout all descriptions and explanations.

Key Points	*Feedback*
Vapor separators.	• Where are vapor separators located within a pressure carburetor? • Where are vapor separators located within the pumps of a direct injection system? • Why do some vapor separators have a float incorporated within the vapor chamber?
Vapor vents.	• Why is a vapor vent located in the top of a vapor chamber? • Where are the vent lines from the carburetor or fuel pump generally routed?

- What fuel metering problem may be encountered if a fuel metering system is supplied with fuel containing air or fuel vapor?

Activities	*Check Items*
	Did the student:
Label the drawing, identifying the components of a specific system.	• Use and correctly interpret information pertaining to the vapor separator and vapor venting system?
Explain the function of the vapor eliminating system.	• Use correct nomenclature as a part of the explanation?

COMPARE CONTINUOUS FLOW FUEL INJECTION AND DIRECT CYLINDER INJECTION SYSTEMS.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- Given:
  Pictures, diagrams, schematics of written information pertaining to the continuous flow method of fuel injection and the direct cylinder injection system.

- Performance:
  The student will describe the two systems and will name the components that are required for operation of each system.

- Standard:
  Correct nomenclature will be used when naming the components of each system.

Key Points	*Feedback*
Continuous flow injection.	• Why is an auxiliary or boost pump necessary to the operation of a continuous flow system? • What is the source of fuel pressure during all normal operation of the system? • Why are surge tanks or acceleration fuel supply tanks located close to the engine driven pump of the injector system? • Why is it impossible to have fuel flow to the injector nozzles when the mixture control is in the idle cut-off position? • What is the purpose of the distributor valve in a continuous flow system? • Why is each injection nozzle supplied with an air bleed? • What is the significance of the identification letter, i.e., "A, B, C, D" that is stamped into the body of the injector nozzle?
Direct cylinder injection.	• What is the purpose of a master control unit? • Where are direct injector pumps mounted on the engines? • Why is the fuel injection pump timed to the engine? • How is the fuel routed from the injector pump to the injection nozzle?

INSPECT, REMOVE AND INSTALL A FLOAT TYPE CARBURETOR, OPERATE THE ENGINE AND ADJUST IDLE SPEED AND IDLE MIXTURE.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- Given:
  An operational engine equipped with a float carburetor, appropriate written operating and service instructions for the specific engine and carburetor.

- Performance:
  The student will inspect, remove and install the carburetor and operate the engine. He will adjust the idle speed and idle mixture.

- Standard:
  The procedure will be in accordance with the written service instructions. The adjustments will result in an engine operating condition within the tolerances specified in the operating instructions.

Key Points	*Feedback*
Inspection, removal and installation.	• What publication would include information describing the procedure to be followed when removing and installing a float type carburetor?

	If inspection of the carburetor indicates a worn throttle shaft, what operational problem should be anticipated? If the carburetor is heavily stained with fuel stain, what operational problem should be expected?
Operation and adjustment.	Why should normal operating temperatures be established before attempting to adjust the carburetor? Why is it good practice to check the throttle spring back and mixture control rigging before adjusting the carburetor? How will the application of carburetor heat affect idle mixtures and idle RPM? What specifications are available to the mechanic in order to determine the recommended idle speed for a specific airplane? What is the effect of field elevation on the adjustment of a carburetor?

Activities	*Check Items* Did the student:
Inspect, remove and install a float carburetor on an engine. Adjust idle speed and idle mixture.	Use the reference manual and follow the specified procedure? Achieve an adjustment within the specified tolerances?

INSPECT, REMOVE AND INSTALL A PRESSURE CARBURETOR OR FUEL INJECTION SYSTEM, OPERATE THE ENGINE AND ADJUST IDLE SPEED AND IDLE MIXTURE.

(SEGMENT G, LEVEL 3)

Student Performance Goal

- Given:
  An operational engine equipped with a pressure carburetor or a fuel injection system, appropriate written operating and service instructions for the specific engine and fuel metering system.
- Performance:
  The student will inspect, remove and install the carburetor or fuel injection system and operate the engine. He will adjust the idle speed and idle mixture.
- Standard:
  The procedures will be in accordance with the written service instructions. The adjustment will result in an engine operating condition within the tolerances specified in the operating instructions.

Key Points	*Feedback*
Inspection, removal and installation.	Where would a mechanic locate information describing the inspection procedure applicable to a pressure carburetor or fuel injection system? Where would information specifying the inspection frequency for fuel filters in the system be located? Where would a mechanic find information describing the sequence or procedure to be followed in removing and installing a pressure carburetor?
Operation and adjustment.	What starting problems may occur when re-starting a hot engine that is equipped with fuel injection? Why is the rigging of the throttle and mixture control important to the adjustment of idle speed and idle mixture? What information should guide a mechanic in determining the recommended idle speed for a specific airplane?

Activities	*Check Items* Did the student:
Inspect, remove and install a pressure carburetor or fuel injection system. Adjust idle speed and idle mixture.	Use the reference manual, correctly interpret information and follow recommended procedures? Achieve an operation condition following the adjustment that met the tolerances specified?

IDENTIFY THE DANGERS OF EXCESSIVELY RICH AND EXCESSIVELY LEAN FUEL-AIR MIXTURES.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- Given:
  A 20 question matching type of examination relating the cause and effect of excessively rich and excessively lean fuel-air mixtures; 10 examples of engine components that have been damaged by rich and lean mixtures (valves, exhaust manifolds, carburetor heat boxes, etc.) and manufacturer's service manuals.

- Performance:
  The student will match the described effect with the probable cause and select a typical component that reflects the condition described by the examination question.

- Standard:
  Fifteen questions will be correctly answered. The student will correctly identify five engine components that show evidence of damage due to incorrect fuel-air mixtures.

Key Points	*Feedback*
Indications of incorrect mixtures.	• Why will an engine backfire during starting? Is it always the result of incorrect ignition? • What hazard should a mechanic associate with overpriming? • Why is the fuel metering system intentionally designed and adjusted to provide a rich mixture during idling and full power operation? • Describe the flame propagation rates of various fuel-air mixtures.
Visual indications.	• What visual evidence inside an exhaust stack indicates correct fuel-air mixtures? What visual evidence indicates excessively rich or excessively lean mixture? • What fuel-air ratios are most conducive to detonation within the cylinder? • What is a typical cause for afterburning? • Distinguish between preignition and detonation. • How does the mixture adjustment effect the temperatures of the exhaust gasses?

Activities	*Check Items*
	Did the student:
Match the cause and effects described in the examination.	• Use and correctly interpret information from the reference manual?
Select damaged components and describe probable cause.	• Indicate by response to the examination that he could interpret nomenclature and terms?
	• Correctly identify cause of damage to five components?

RIG THE FUEL CONTROL UNIT ON A STATIC TURBOJET ENGINE AND DESCRIBE THE TRIMMING OF THE ENGINE..

(SEGMENT I, LEVEL 2)

Student Performance Goal

- Given:
  A turbojet engine, statically mounted to include a thrust lever, fuel control unit and associated instrumentation and linkage necessary to trimming of the engine and written instructions describing the procedure for accomplishing this adjustment.

- Performance:
  The student will interpret the information, describe and simulate the procedure for rigging the fuel control and trimming a turbojet engine.

- Standard:
  Reference information will be correctly interpreted. Correct nomenclature and terminology will be used throughout the description of the procedure.

Key Points	*Feedback*
Fuel flow schedules.	• What is meant by the term "scheduled fuel flow"? • What design considerations limit the power available from a turbojet engine? • Why does a fuel metering unit often incorporate a governor and a bellows?
Operational limitations.	• What is meant by the term "lean flame out"? • What is "rich blow out"? • What is compressor stall or surge?

	• What problems are associated with overspeed and over-temp? • What is the relationship between engine RPM and "engine pressure ratio"? • What are the approximate fuel-air mixtures used in jet engines?
Rigging fuel controls.	• How are thrust lever positions and fuel control unit positions measured? • What publications would a mechanic use to determine the trimming procedure applicable to a specific jet engine?

Activities	*Check Items*
	Did the student:
Describe and simulate the procedure for trimming a jet engine.	• Use and correctly interpret the reference information? • Use correct terminology as a part of the description?

7. OVERHAUL CARBURETORS. (EIT = 20 hrs., T = 12 hrs., L/S = 8 hrs.) 8 segments

(UNIT LEVEL 2)

IDENTIFY VENTURI SIZE AND DESCRIBE FUNCTION.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Typical aircraft carburetors, both float and pressure types, incorporating round, rectangular and boost venturi; reference manuals or written information specifying the size and describing the venturi to be used in a specific carburetor.

- **Performance:**
  The student will interpret information from the reference publications, point to the venturi in one specific carburetor and identify the venturi by size or part number. He will describe the function of a venturi in a carburetor.

- **Standard:**
  Reference information will be correctly interpreted. Correct nomenclature will be a part of the description.

Key Points	*Feedback*
Function of a venturi.	• What is meant by a "pressure differential"? • Why do some carburetors have more than one venturi? • Why are rectangular rather than round venturis used on some installations? • How would a loose venturi or a venturi that was out of correct position effect the fuel metered by a carburetor? • What is the relative position of the discharge nozzles in the venturi?
Identification of venturis.	• What publication would a mechanic use to determine the size of venturi specified for a particular carburetor? • What is the relationship between venturi size and engine displacement or engine size? • At what position is fuel introduced into a venturi in a float carburetor? Where is fuel introduced in a pressure carburetor?

Activities	*Check Items*
	Did the student:
Identify a venturi and determine the size for a specific carburetor.	• Correctly interpret reference information?
Describe the function of a venturi.	• Use correct nomenclature as a part of the description?

INTERPRET AND USE CHARTS OR DIAGRAMS TO EXPLAIN FUEL AND AIRFLOW THROUGH FLOAT AND PRESSURE CARBURETORS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Charts, diagrams, drawings or similar visual aids illustrating the passageways and internal flow paths through float and pressure carburetors, written reference information describing the fuel-air ratios required by the engine at various operating conditions.

- **Performance:**
The student will interpret and use the charts and diagrams to explain fuel and airflow through both float and pressure carburetors.

- **Standard:**
The principles of differential pressures in both fuel and air flows will be correctly explained. Correct nomenclature and terminology will be a part of the explanations.

Key Points	*Feedback*
Idling system operation.	• What reference publication would a mechanic use to determine the idle speed operating range of a specific engine? • What is the position of the throttle when the engine is operating at idle speeds? • At what point in the venturi does the lowest pressure exist when the engine is idling?
Accelerating system operation.	• What operational system would indicate a malfunction of the accelerating system? • If the engine responds to the initial throttle movement, but is unable to sustain the acceleration, what problem exists?
Cruise power operation.	• At approximately what RPM do the carburetors begin to meter fuel through the main discharge systems? • If the engine gives evidence of operating too lean in the cruise power range, what difficulty may exist in the carburetor? • What fuel or airflow problem in a carburetor could result in excessively rich mixtures during cruise power?
Full power operation.	• What is the fuel-air ratio intentionally scheduled to provide a rich mixture for full power operation? • What features in the carburetors provide the additional fuel flow required at takeoff power operation?
Altitude mixture control.	• Describe the method of reducing fuel flow to achieve the required leaning of the mixture as altitude is increased. • What methods may be used to determine the correct fuel-air ratio at any desired cruising altitude? • Explain how a mixture control may be provided with an "idle cut-off."

Activities	*Check Items* Did the student:
Trace and describe fuel and airflow through a float type carburetor. Trace and describe fuel and airflow through a pressure carburetor.	• Correctly trace and describe flows at various engine operating conditions? • Use correct nomenclature and terminology throughout the explanations and descriptions of operation? • Correctly interpret technical reference information pertaining to fuel-air ratios?

REMOVE, INSTALL AND EXPLAIN THE PRINCIPLES OF FUEL METERING THROUGH A JET.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
A typical aircraft carburetor incorporating a fixed orifice jet, reference drawings or information describing the location, size and function of the jet and special tools necessary to remove and reinstall a jet.

- **Performance:**
The student will remove, measure the size and reinstall a metering jet in a carburetor. He will use and interpret information from reference information and explain the purpose of the jet.

- **Standard:**
The procedure and tools used to remove, measure and reinstall the jet will be in accordance with written instructions contained in the reference manual. Correct nomenclature will be used throughout the explanation.

Key Points	*Feedback*
Absolute and differential pressures.	• What is absolute pressure? • What is differential pressure? • How may fuel flow through a fixed size of metering jet be increased? • If two jets are installed in series, how is the fuel flow and pressure effected?
Measuring jet sizes.	• What is the significance of the number or letter that is often stamped on a jet?

	• If appearance indicates that a jet has been reamed oversize, what device is used to measure the jet size? • During the overhaul of a carburetor, what acceptable method of cleaning a jet exists?
Installation and removal of jets.	• Where would a mechanic find information describing the procedure and tools to be used? • How would a loose jet effect the metering of fuel through the jet?

Activities	*Check Items*
	Did the student:
Remove, inspect, measure and reinstall a jet.	• Use and correctly interpret information? • Follow correct procedures and avoid damage to components and tools?
Describe the function of a jet.	• Use correct nomenclature and terminology as a part of the explanation?

IDENTIFY AND DESCRIBE THE OPERATION OF AN AIR BLEED.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  A typical carburetor incorporating an air bleed; a schematic or diagram of the carburetor and written reference information describing the operation of the air bleed in the specific carburetor.
- Performance:
  The student will disassemble the carburetor to the degree that he may point to the air bleed. He will interpret reference information and describe the operation of the air bleed.
- Standard:
  The air bleed will be correctly identified. Correct nomenclature will be used as a part of the explanation and description of operation.

Key Points	*Feedback*
Principles of air bleeds.	• Why is an air bleed incorporated into an idling system of a carburetor? • What are the similiarities and differences between an air bleed in the idling and main discharge systems of a carburetor? • Why is the size of an air bleed critical?
Location and function of air bleeds.	• Where would a mechanic find information that described the location of air bleeds in a carburetor? • How would a clogged air bleed in the idle system of a carburetor effect engine operation? • At what engine speeds (RPM) would the air bleed in the main discharge system be operating?

Activities	*Check Items*
	Did the student:
Disassemble a carburetor and point to an air bleed and reassemble the carburetor.	• Use and correctly interpret reference information as a means of locating the air bleed?
Describe the principle of air bleed operation.	• Use correct nomenclature as a part of the explanation?

LOCATE AND DESCRIBE THE OPERATION OF THE MAIN DISCHARGE NOZZLE IN A PRESSURE CARBURETOR.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:
  A typical pressure discharge aircraft carburetor; appropriate drawings, schematic diagrams and reference information.
- Performance:
  The student will point to the main discharge nozzle of a pressure carburetor and describe the operation and possible malfunctions of the main discharge system.
- Standard:
  The discharge nozzle will be correctly identified. Correct nomenclature will be a part of the explanation and description of the operation. Reference information will be correctly interpreted when describing malfunctions of the system.

Key Points	*Feedback*
Location of main discharge nozzles.	• Where is the main discharge nozzle of a pressure carburetor located with respect to the throttle and venturi? • What is the advantage of introducing the fuel into the manifold so that the fuel-air mixture does not pass through the venturi? • What is the advantage of pressure discharge of the fuel?
Malfunctions of the system.	• What is the effect of ruptured fuel nozzle diaphragm on a pressure carburetor? • How is the main discharge system related to failure of the engine to accelerate? • How is a malfunction of the main discharge system of a pressure carburetor related to engine idling?

Activities	*Check Items*
	Did the student:
Identify and point to the location of the main discharge nozzle of a pressure carburetor.	• Use and correctly interpret the drawings and reference information? • Correctly identify and locate the nozzle?
Describe the operation and possible malfunction of the main discharge system.	• Use correct nomenclature as a part of the description and explanation?

IDENTIFY ACCELERATION SYSTEMS IN FLOAT AND PRESSURE CARBURETORS AND DESCRIBE THE OPERATION OF EACH SYSTEM.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  A typical aircraft float carburetor incorporating a pump type accelerating system, a cutaway pressure carburetor displaying the accelerating system, appropriate drawings, schematic diagrams and reference information describing the operation of the acceleration systems of each carburetor.

- Performance:
  The student will identify the acceleration systems in each carburetor, associate the components with the drawings or diagrams and interpret reference information describing the operation of each system.

- Standard:
  Components of the acceleration systems will be correctly identified. Correct nomenclature will be a part of the explanation and description of operation.

Key Points	*Feedback*
Kinds of accelerators.	• Describe why a pump or diaphragm type of acceleration system is more positive than an accelerating well. • In a pump type accelerating system, what is the effect of a spring that may be mounted beneath the piston of the pump? • In a diaphragm type accelerating system, what force discharges the fuel and aids in the atomization of the liquid?
Function of the accelerating system.	• Why is an accelerating system necessary in a carburetor? • If an accelerating system fails to operate as designed, what is the effect on the engine? • Why doesn't the accelerator function as the throttle is slowly opened?

Activities	*Check Items*
	Did the student:
Identify and point to the location of the accelerating system in both types of carburetors.	• Correctly identify the components of the systems? • Correctly interpret drawings, diagrams and reference information?
Describe the operation of accelerating systems of carburetors.	• Use correct nomenclature as a part of the explanation and description of operation?

IDENTIFY ECONOMIZER AND POWER ENRICHMENT SYSTEMS AND DESCRIBE THE OPERATION OF THE SYSTEMS IN FLOAT AND PRESSURE TYPE CARBURETORS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- Given:
  A typical aircraft float carburetor incorporating an economizer, a cutaway pressure carburetor displaying the power enrichment valve, appropriate drawings, schematic diagrams and reference information describing the operation of the economizer and power enrichment systems.

- **Performance:**
  The student will identify the economizer and power enrichment components in each carburetor, associate the components with drawings or diagrams and interpret reference information describing the operation of each system.

- **Standard:**
  Components of the systems will be correctly identified. Correct nomenclature will be a part of the explanation and description of the operation.

Key Points	*Feedback*
Economizer and power enrichment systems.	•At what power (RPM) is an economizer or power enrichment system necessary to engine operation? •Why is a rich mixture required for engine operation at high power conditions?
Enrichment systems.	•What are the limitations to the use of a mechanically actuated or linked economizer system? •What are some of the advantages and limitations to the use of diaphragm actuated power enrichment systems? •If an economizer should open at a specified throttle position, but is opening much too soon, how will fuel consumption be affected? •What repair agency most generally makes the adjustments required for proper operation of a power enrichment valve?

Activities	*Check Items*
	Did the student:
Identify and point to the location of the economizer and power enrichment systems on both types of carburetors.	•Correctly identify the components of the systems? •Correctly interpret drawings, diagrams and reference information?
Describe the operation of the economizer and power enrichment systems.	•Use correct nomenclature as a part of the explanation and description of operation?

IDENTIFY MIXTURE CONTROLS INCORPORATED IN FLOAT AND PRESSURE CARBURETORS AND DESCRIBE THE OPERATION OF THE SYSTEM.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- **Given:**
  Typical float and pressure type aircraft carburetors incorporating needle type, back suction type, and automatic mixture control devices; appropriate drawings, schematic diagrams and reference information describing the operation of the mixture control systems.

- **Performance:**
  The student will identify the mixture control components in each carburetor, associate the components with the drawings or diagrams and interpret the reference information describing the operation of the mixture control systems.

- **Standard:**
  Components of the systems will be correctly identified. Correct nomenclature will be a part of the explanation and description of operation.

Key Points	*Feedback*
Air density effects.	•Why is it necessary to reduce fuel flow as air density decreases? •What is the effect of altitude and temperature on the density of air? •How will a decrease of air pressure in the float chamber of a carburetor result in a decreased fuel flow?
Mixture control systems.	•What is the source of vacuum for a back suction type of mixture control? •What control is necessary from the pilot's position in the airplane to control the mixture on a manually operated system? •Where is the mixture control handle most generally located? Why is this control often provided with an "idle-cut-off"? •What is the advantage of an automatic mixture control system?

Activities	*Check Items*
	Did the student:
Identify and point to the mixture control lever on the carburetor. Identify and point to the automatic mixture control of a pressure carburetor. Describe the operation of mixture control systems.	•Correctly identify the components of the systems? •Correctly interpret drawings, diagrams and reference information? •Use correct nomenclature as a part of the explanation and description of operation?

8. REPAIR ENGINE FUEL METERING SYSTEM COMPONENTS. (EIT = 6 hrs., T = 3 hrs., L/S = 3 hrs.) 4 segments

(UNIT LEVEL 2)

LOCATE, REMOVE, CLEAN AND REINSTALL SCREENS IN FUEL METERING SYSTEM COMPONENTS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  A typical aircraft carburetor or fuel metering device incorporating a fuel inlet screen; manufacturer's service information applicable to the specific unit; and recommended materials, tools and equipment as recommended in the reference information.

- **Performance:**
  The student will use and interpret information necessary to identify, remove, clean and reinstall the screens in the fuel metering unit.

- **Standard:**
  The procedures, tools and techniques recommended in the service information will be followed without error or omission. The task will be accomplished at a return-to-service standard.

Key Points	*Feedback*
Contamination of fuel metering components.	•Why are fuel screens usually located in the inlet passageways to carburetors and other fuel metering devices? •Why does dust often accumulate in the vents, housings and venturi sections of a carburetor? •What contamination may accumulate in the float chamber of a carburetor? •What degree of wear occurs in the metering jets of a carburetor? How may contamination affect fuel flow through a jet?
Cleaning of fuel metering components.	•Where would a mechanic find information specifying the inspection frequency and cleaning methods to be followed? •What procedure should be followed to clean a fuel screen in a carburetor? The float chamber and metering jets? •Why should wiping cloths never be used when cleaning fuel metering components? •How should a stuck gasket be removed from a carburetor parting surface? •What precautions should be observed when using decarbonizing type solvents and compressed air to clean carburetor parts?

Activities	*Check Items*
	Did the student:
Locate, remove, clean and reinstall screens in a fuel metering unit.	•Correctly use and interpret reference information? •Follow recommended procedures and avoid damage to components and tools? •Achieve a standard of workmanship that would permit return-to-service.

INSPECT AND DESCRIBE THE REPAIR OF CARBURETOR FLOATS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Five typical floats from aircraft carburetors (two will be unacceptable for return-to-service), representing floats that were made of brass, stainless steel and moulded rubber; reference information describing the inspection and repair of floats.

- **Performance:**
  The student will inspect the floats, interpret the reference information and describe the repair of carburetor floats.

- **Standard:**
The two unacceptable floats will be identified and the reason for rejection will be explained. Reference information will be correctly interpreted. Correct nomenclature will be used as a part of the description of repairs.

Key Points	*Feedback*
Inspection of floats.	• Where would a mechanic find information describing the inspection and repair of floats? • What evidence will alert a mechanic to a carburetor with a leaking float? • How can a float be checked for leaks?
Repair of floats.	• What is the effect of applying heat to a float that has contained gasoline? • What soldering procedure must be used on metal floats? • What procedure will be effective in removing fuel and fumes from a float? • What limitations apply to repairs of moulded rubber floats?

Activities	*Check Items* Did the student:
Inspect and identify the defective floats. Describe the repair of floats.	• Use and correctly interpret information? • Correctly identify the defective units? • Use correct nomenclature as a part of the description of repairs?

INSPECT FLOAT NEEDLE AND SEAT, MEASURE AND ADJUST FLOAT LEVEL OF A CARBURETOR.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
A float carburetor with two replacement float needles and valve seat assemblies, one of which is unserviceable; a manufacturer's service manual and recommended equipment necessary to measure and adjust the float level of the carburetor.

- **Performance:**
The student will inspect the needle and seat assemblies and identify the serviceable assembly. He will install the serviceable needle and seat assembly and adjust the float level.

- **Standard:**
All procedures will be in accordance with the information contained in the manual. Information will be correctly interpreted and the adjusted float level will be within specified tolerance.

Key Points	*Feedback*
Needle and seat assemblies.	• What causes wear between the needle and seat in a carburetor? • Why are some needles provided with a neoprene tip? • How will a grooved needle effect engine operation? • What reference information is available to the mechanic to guide his inspection of a needle and seat assembly?
Adjustment of float level.	• What difference will exist between a needle and seat designed for a gravity flow and a pressure fuel system? • What are the effects of an improperly adjusted carburetor float level? • What is capillary action and how does this effect the measurement of fuel level in the float chamber? • What is "drop" of a float and how could inadequate drop effect engine operation? • Why is accurate fuel pressure required when checking float level in a carburetor? • Where would information specifying the correct float level be found? • How is the float level measured? • How is the float level adjusted?

Activities	*Check Items* Did the student:
Inspect the replacement needle and seats and identify the unservicable unit. Install the needle and adjust the float level of the carburetor.	• Correctly interpret manufacturer's specifications? • Follow the recommended procedures, correctly use tools and avoid damaging components? • Achieve an adjusted float level within specified tolerances?

INSPECT A PRESSURE TYPE CARBURETOR AND DESCRIBE OPERATION RESULTING FROM CLOGGED IMPACT TUBES AND RUPTURED DIAPHRAGMS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  Examples of pressure type carburetors, at least one of which will have clogged impact tubes and a ruptured fuel or air diaphragm; drawings or schematic diagrams of the specific carburetor; reference information describing the function of impact tubes and diaphragms within the carburetor.

- Performance:
  The student will identify the clogged impact tubes and point to the impact tubes as they are identified on the drawing or schematic. He will explain the relationship of the impact tubes to the pressure regulator and automatic mixture control unit of the carburetor. He will explain the effect of a ruptured fuel or air diaphragm on the operation of an engine.

- Standard:
  The carburetor with clogged impact tubes will be detected. Reference information will be correctly interpreted and explanations and descriptions will include use of correct nomenclature.

Key Points	*Feedback*
Purpose of impact tubes.	•What pressure does the impact tube transmit? •What kind of icing would most likely effect the carburetor impact tubes? •How could foreign materials obstruct the impact tubes?
Regulator diaphragms.	•How are the fuel and air chambers within a pressure carburetor separated? •What procedure is necessary to keep the diaphragms in a flexible condition? •How would a ruptured diaphragm in either the fuel or air chambers of the regulator unit effect engine operation? Who is authorized to install diaphragms in a pressure carburetor?

Activities	*Check Items* Did the student:
Identify clogged impact tubes and explain relationship between impact tubes and regulator and automatic mixture unit.	•Correctly identify the carburetor with clogged impact tubes?
Describe the effect of ruptured diaphragms in a pressure carburetor.	•Correctly interpret reference information and explain effect of impact tubes to regulator and mixture control unit? •Use correct nomenclature as a part of the description and explanations?

9. **INSPECT, CHECK, AND SERVICE WATER INJECTION SYSTEMS.** (EIT = 2 hrs., T = 2 hrs., L/S = 0 hrs.) **1 segment**

(UNIT LEVEL 1)

LOCATE INFORMATION REGARDING THE INSPECTION, CHECKING, AND SERVICING OF WATER INJECTION SYSTEMS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written reference information pertaining to water injection systems.

- Performance:
  The student will locate information and answer a twenty question multiple choice examination dealing with the effect of atmospheric humidity; depletion of water injection during takeoff; variables that effect the water flow and indications of incorrect flow rate; purpose of the derichment valve and the effects of failure of the valve on high power performance.

- Standard:
  Reference information will be located and fifteen of the multiple choice questions will be correctly answered.

Key Points	*Feedback*
Effects of atmospheric humidity.	•What is the primary purpose of water injection – to increase power or to decrease fuel consumption? •Does water injection increase or diminish the possibility of detonation?
Water flow (ADI).	•Does high atmospheric humidity permit more or less water injection? •Is the mixture made richer or leaner when ADI is operating? •Does a derichment valve increase or decrease the amount of fuel delivered to the engine?

	• Is the derichment valve controlled by water pressure? Or fuel pressure? • What kinds of interlocks are used to prevent ADI operation when the engine is not running?
ADI fluid.	• What is the purpose of the alcohol in the ADI fluid? • How is the ADI fluid mixed and measured? • What kind of corrosion is common to the components of the ADI system? • What process may be used to minimize the corrosion caused by the water of the ADI?
Detonation and ADI.	• Would high or low cylinder head temperatures be an indication of detonation while using ADI? • What procedures would be used to shut down an engine that was detonating? • Explain what components of the engine are subjected to the most abuse by detonation.

10. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR ENGINE ICE AND RAIN CONTROL SYSTEMS. (EIT = 4½ hrs., T = 2 hrs., L/S = 2½ hrs.) 3 segments

(UNIT LEVEL 2)

DESCRIBE INDUCTION ICING AND IDENTIFY PROBABLE LOCATION.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Unlabeled drawings of an air induction system for supercharged and unsupercharged reciprocating engines and a turbine engine and appropriate texts or manufacturer's manuals.
- **Performance:**
  The student will interpret the reference publications and describe the formation of ice in the induction systems of both reciprocating and turbine engines. He will label the line drawings to illustrate the most common location for the build up of ice in the induction system.
- **Standard:**
  Reference information will be correctly interpreted and the illustrations will be correctly labeled. Correct nomenclature will be used as a part of the description.

Key Points	*Feedback*
Induction system icing.	•Where does impact ice develop in the intake system to the engine? •What causes "carburetor ice" in an engine? •What temperature range and relative humidity is most likely to cause carburetor icing?
Effects on engine performance and instrument indications.	•On an engine equipped with a fixed pitch propeller, what is the first indication of carburetor ice? What instrument indicates carburetor ice if the engine is equipped with a constant speed propeller? •What response may be expected on the carburetor air temperature gauge, oil temperature and cylinder head temperature when icing has occured?

Activities	*Check Items*
	Did the student:
Label the induction system drawings and indicate where icing will most likely occur. Describe the conditions and the effects of icing in the intake systems to the engine.	•Correctly identify the components of an intake system? •Correctly interpret reference information? •Use correct nomenclature and terminology during the descriptions?

INSPECT, CHECK, SERVICE AND REPAIR A CARBURETOR PRE-HEAT SYSTEM OR HOT SPOT.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  A typical carburetor pre-heat system incorporating an exhaust muff heater, connecting hose and shutter operated heat box; an intake manifold hot spot; appropriate reference information pertaining to carburetor heaters and hot spots.
- **Performance:**
  The student will inspect, check, and service the heater muff, connecting duct and heater box and shutter. He will describe the repairs that are normally accomplished and will verify that the shutter of the heat box has full travel.
- **Standard:**
  The student will correctly detect any defects that exist in the system. The system will function as it was designed to operate or necessary adjustments will be made by the student to achieve this standard. Correct nomenclature will be used during all descriptions of repairs.

Key Points	*Feedback*
Operation of pre-heat systems.	•What is the source of heat necessary for operation of the system? •Describe the path of air as it enters the cowl, is heated and then directed into the carburetor air intake. •What is the required temperature rise in a pre-heat system?
Inspection, checking and servicing of a pre-heat system.	•Why is it necessary to remove the heater muff when inspecting the heater assembly?

	• Where would a mechanic find specific information describing an inspection and testing of the heater manifold? • Why must the flexible air duct meet minimum temperature requirements before it is approved for installation into the system? • What problems are related to cracks in the exhaust manifold beneath the heater muff? • Why must the shutter in the carburetor heat box have full travel and operate smoothly? • What is meant by "spring-back" when rigging or adjusting the travel of the carburetor heat control? • Why is the heater box provided with an outlet which dumps the heated air overboard when the carburetor heat control is in the "cold" position?
Repairs to carburetor heat systems and hot-spots.	• What problems are associated with repairs involving welding of the exhaust manifolds? • What is a "hot-spot" intake system heater? What is the source of heat in a "hot-spot"? • What publication would describe the repairs that are approved and recommended for carburetor heaters and hot-spots?

Activities	*Check Items*
	Did the student:
Inspect, check and service the heater muff, connecting duct, heater box and shutter. Describe repairs to carburetor heat systems and hot-spots. Verify full travel of the shutter in the carburetor heat box.	• Follow the procedures recommended and prescribed in the service instructions? • Correctly interpret reference information? • Use correct nomenclature as a part of the description?

DESCRIBE THE OPERATION OF THERMAL ANTI-ICING SYSTEMS FOR TURBINE ENGINE AIR INTAKES.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
  Written reference information, drawings or schematics describing and illustrating thermal anti-icing of turbine engine air intakes.

- **Performance:**
  The student will interpret the information and drawings and describe the operation of the anti-icing systems.

- **Standard:**
  Reference information will be correctly interpreted. Correct nomenclature and terminology will be used to describe the operation of the systems.

Key Points	*Feedback*
Heated air inlet ducts.	• If the duct is heated with hot air, what is the source of this heated air? • Where would a mechanic find information describing the operation of the system employed in a specific airplane? • When air inlets are electrically heated, where are the heating elements generally located?
System operation.	• What provision is made in the heating system for the air intakes to avoid overheating the structure? • Where would specific information pertaining to inspection and repair of the systems be found?

Activities	*Check Items*
	Did the student:
Describe the operation of a hot air system. Describe the operation of an electrically heated air intake system.	• Correctly interpret reference information and drawings? • Use correct nomenclature when describing system operation?

11. INSPECT, CHECK, SERVICE, AND REPAIR HEAT EXCHANGERS AND SUPERCHARGERS.

(EIT = 7½ hrs., T = 4 hrs., L/S = 3½ hrs.)
3 segments

(UNIT LEVEL 2)

INSPECTION AND REPAIR OF SUPERCHARGERS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Typical superchargers of the mechanically driven and exhaust turbo types, sufficiently complete, but not necessarily capable of being operated, that the supercharger may be inspected in accordance with the manufacturer's manual and the required repairs described.

- **Performance:**
  The student will inspect a mechanically driven and an exhaust turbo supercharger. He will make measurements of clearance and visual inspection for defects and describe the repairs as recommended by the manual.

- **Standard:**
  Reference information will be correctly interpreted. The inspection and description of repair will be in accordance with the manufacturer's manual.

Key Points	*Feedback*
Types of superchargers.	• What are the primary differences between a mechanically driven and an exhaust turbosupercharger? • What is the energy source or power source for a turbosupercharger? • How is the engine power available at the crankshaft linked to a mechanically driven supercharger? • Describe how the impeller of a mechanically driven supercharger may be driven at two different speeds.
Supercharger controls.	• Explain how the position of a wastegate controls the output of a turbo-supercharger. • What hazard is associated with a mechanically linked or pilot operated control to the turbo-supercharger? • If the action of a turbosupercharger is automatically regulated, what engine pressure is sensed in order to avoid overboosting?
Lubrication of turbo-superchargers.	• Where would a mechanic find information pertaining to the correct lubrication and lubricants required for a turbo-supercharger? • What problems are associated with "coking" of the shaft seals on a turbosupercharger?
Inspection and repair of superchargers.	• What are the causes of cracking of turbines and diffusers in exhaust turbosuperchargers? • What damage will most likely result from failure of the turbo-supercharger shaft seals? • Where would a mechanic find information detailing the inspection and checks that should be made of a supercharger? • Why are supercharger repairs normally accomplished at specially equipped repair stations or overhaul bases?

Activities	*Check Items* Did the student:
Inspect a mechanical and a turbo-supercharger.	• Use and correctly interpret information contained in the reference publications?
Describe the repair of superchargers.	• Use correct nomenclature and correctly establish the limits to repairs as recommended by the manufacturer's manual?

INSPECT, SERVICE AND CHECK A SUPERCHARGER SYSTEM.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  An operational engine or mock-up equipped with a mechanically driven or a turbo-supercharging system, appropriate reference information or manuals describing the operation, servicing and inspection of the system, necessary servicing tools or equipment and an unlabeled line drawing of a normally aspirated, a mechanically driven and turbo-supercharged system.

- **Performance:**

The student will operate the engine or mock-up and check the operation of the supercharger system. He will inspect and service the system as recommended in the reference publications and label each of the three drawings of the intake manifold systems, identifying the approximate pressures and temperature that will exist at various positions in the system.

- **Standard:**

The operation and inspection of the supercharging system will be fully in accordance with the reference publications. The temperature and pressures shown in the drawings will be sufficiently correct that comparisons may be made between the different systems.

Key Points	*Feedback*
Effects of supercharging.	• What is the purpose of an impeller in the induction system of a radial engine if the impeller is driven at relatively low speeds? • At what point in an intake manifold is the manifold pressure gauge connected? • When the intake air to an engine is compressed, what temperature effect takes place? • Does an increase in the induction air temperature tend to enrichen or lean the fuel-air mixture? • What is the purpose of an intercooler in the induction system of a supercharged engine?
Inspection of supercharging systems.	• What would be the effect of an induction leak on a supercharged engine? • What manifold pressure indications would point to a leak in the induction system? • If the engine is turbo-supercharged, what is the effect of a leak in the exhaust system? • Where would a mechanic find information describing the inspection procedure to be followed when inspecting the supercharging system of a specific airplane?

Activities	*Check Items*
	Did the student:
Operate the supercharged engine or mock-up and check system operation. Label the drawings of a normally aspirated, mechanically driven and turbo-supercharged engine induction system to identify approximate temperatures and pressures.	• Follow the recommended procedures? • Correctly interpret instrument indications and reference information? • Correctly identify the systems and identify pressures and temperatures to the degree that comparisons could be made between the different systems? • Use correct nomenclature?

INSPECT HEAT EXCHANGERS AND DESCRIBE METHODS OF REPAIR.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**

Typical aircraft heat exchangers, at least one of which is defective due to cracks, burns or defective radiator core and appropriate reference information or manuals describing the inspection of repair of the specific types of heat exchangers displayed.

- **Performance:**

The student will interpret information contained in the publications and inspect the heat exchangers. He will identify the defective heat exchanger and describe the repair procedure recommended in the manual.

- **Standard:**

Information will be correctly interpreted. The defective heat exchanger will be identified without error or omission. Correct nomenclature will be used to describe the recommended repair.

Key Points	*Feedback*
Heat exchanger operation.	• How is the amount of cooling air flow through a heat exchanger regulated? • In an exhaust muff type heat exchanger, why is a constant flow of air maintained between the manifold and the muff?
Inspection and repair of heat exchangers.	• What publication would a mechanic use to determine the inspection and repair procedures applicable to a heat exchanger?

- What are some of the limitations that might apply to a heat exchanger in which air was used as the cooling medium for oil or hydraulic fluid?
- Why do some heat exchangers require qualification by pressure testing before they may be installed in the system?

Activities	*Check Items*
	Did the student:
Inspect the displayed heat exchangers and identify the defective unit.	• Correctly interpret and follow specified inspection procedures?
Describe repair procedure for a heat exchanger.	• Use correct nomenclature during the description of repair?

12. INSPECT, CHECK, SERVICE AND REPAIR CARBURETOR AIR INTAKE AND INDUCTION MANIFOLDS. (EIT = 6½ hrs., T = 2½ hrs., L/S = 4 hrs.) 4 segments

(UNIT LEVEL 3)

INSPECT, CHECK, SERVICE AND REPAIR AN AIR INTAKE DUCT FOR A CARBURETED ENGINE.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational engine provided with a ram air carburetor intake duct, manufacturer's service information pertaining to the inspection, servicing and repair of the intake ducting.

- **Performance:**
  The student will operate the engine as a means of recognizing normal operation. He will again operate the engine after the instructor has introduced a partial obstruction into the intake air duct and record the symptoms. The student will inspect, check, service and repair the system to correct the obstruction in the intake duct.

- **Standard:**
  Operation of the engine, inspection, checking, servicing and repair will be in accordance with the recommendations contained in the manufacturer's service information. The intake duct and engine will operate normally following correction of the fault.

Key Points	*Feedback*
Ram air ducts.	• How does a ram air duct effect engine operation? • What factors are considered in determining the location of a ram air inlet? • How do internal baffles assist in the control of ram airflows?
Inspection of ducts.	• How do leaks in a ram air duct effect the efficiency of the system? • What methods may be employed to seal the flexible joints and avoid chafing in a duct? • Why is the security and integrity of a ram air duct of such importance?
Repair of air ducts.	• Where would information describing the approved repairs to ducts be located? • What is the consequence of making patches inside a duct in such a manner that the patch might affect airflow in the duct? • What importance should a mechanic give to a loose baffle in a ram air duct? • What precautions should be observed with regard to foreign objects (rags, dirt, rocks, etc.) which may be inadvertently left in a ram air duct?

Activities	*Check Items*
	Did the student:
Operate the engine and record normal instrument indications and engine response.	• Follow the recommended procedures?
Operate engine with partial obstruction in intake duct.	• Correctly interpret service, inspection and repair information?
Inspect, check, service and repair the intake duct.	• Detect and record changes in instrument indications and engine response? • Achieve normal operation following correction of the fault?

INSPECT, CHECK, SERVICE AND REPAIR A CARBURETOR HEATER SYSTEM.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
An operational engine that is equipped with a carburetor heater system, manufacturer's service manuals or equivalent written reference information describing the inspection, servicing, adjustment and repair of the carburetor heater system.

- **Performance:**
The student will operate the engine with a carburetor heat control that is improperly rigged. He will record the instrument indications and re-rig and adjust the carburetor heat control.

- **Standard:**
Engine operation will be in accordance with the written reference information. Information will be correctly interpreted and the rigging and adjustment of control travel and response will meet return-to-service standards.

Key Points	*Feedback*
Engine response to carburetor heat.	•What should be the position of the carburetor heat control while starting the engine? •How does an engine respond to the application of carburetor heat at takeoff power? •Why should carburetor heat be applied prior to a reduction in power from cruise to idle? •If induction icing has occured, how does the engine first respond when carburetor heat is applied?
Inspection, servicing and repairing of carburetor heater systems.	•Where would a mechanic find information pertaining to the inspection of a carburetor heat system? •What procedure should be followed to ensure correct travel of the shutter in the carburetor heat box? •What is meant by the term "spring-back" as applied to the adjustment of travel for the carburetor heat control? •Why are all carburetor heat controls placarded "pull for carburetor heat"?

Activities	*Check Items* Did the student:
Operate the engine with the carburetor heat control improperly rigged.	•Correctly interpret information from the servicing manual and detect improper rigging?
Re-rig and adjust the carburetor heat control in accordance with service instructions.	•Achieve an adjustment and rigging that met with return-to-service standards?

INSPECT AND SERVICE AIR SCREENS OR AIR FILTERS IN THE ENGINE AIR INTAKE.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- **Given:**
An engine air intake or mock-up incorporating an air screen or air filter; manufacturer's service instructions and the equipment and materials recommended to inspect and service air screens and filters.

- **Performance:**
The student will remove the screen or filter from the airplane or mock-up, inspect, service and reinstall the unit into the engine air intake. He will describe the rigging of an alternate air intake door.

- **Standard:**
Service instructions will be interpreted without error or omission. The completed job will reflect return-to-service standards.

Key Points	*Feedback*
Location of air intake screens and filters.	•What are some of the disadvantages to the location of an air intake screen at the bottom of the engine cowl? •What reference information is available to a mechanic as a guide to the location of the air intake filters in a system? •Why are air intake systems provided with an alternate air door? •Why are the ducts which supply heated air to the carburetor not provided with air filters?
Inspection, servicing and installation of screens and filters.	•Where would a mechanic find information describing the inspection, servicing and installation of screens and filters?

- What precautions would generally apply to the cleaning and servicing of a paper type air filter?
- If the service instructions recommend the application of oil to the screen, what is the purpose of draining the screen prior to reinstalling it in the airplane?
- What is the importance of removing dust and dirt from the intake passageway before reinstalling the filter?
- Why should air intake screens and filters be installed with close fitting gaskets or seals?

Activities	*Check Items*
	Did the student:
Remove, clean, service and reinstall an air intake filter.	• Correctly interpret reference information and follow recommended procedures? • Accomplish the task at a return-to-service standard?
Describe the inspection and rigging of an alternate air intake door.	• Use correct nomenclature as a part of the description?

INSPECT, CHECK, SERVICE AND REPAIR AN ENGINE PRIMER SYSTEM.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational engine priming system, mounted in an airplane or on a mock-up, written service instructions pertaining to the inspection, servicing and repair of the system, and gaskets, seals and tools normally required in the repair of the system.
- **Performance:**
  The student will operate, inspect, service and repair the priming system correcting a fault introduced into the system by the instructor.
- **Standard:**
  The system will operate as it was designed to operate and will be free of internal and external leaks.

Key Points	*Feedback*
Priming systems.	• Why is an engine primed prior to starting? • At what point in the induction systems may the priming fuel be introduced? • What is the source of fuel for the priming system? • What factors determine the amount of priming anticipated? • What is the difference between a hand operated pump-type primer and an electric solenoid primer?
Inspection, servicing and repair of priming systems.	• Where would a mechanic find information pertaining to a specific priming system in use on an airplane? • What evidence aids a mechanic in detecting a primer that is leaking externally? • What operational symptoms would alert a mechanic to an internal fuel leak through a faulty primer? • How are the inlet and discharge ports on a hand operated primer identified? • How would the operation of an electric solenoid primer be checked?

Activities	*Check Items*
	Did the student:
Operate priming system and check for normal operation.	• Use and correctly interpret reference information before checking system operation?
Inspect, service and repair system — correcting an induced fault.	• Follow the inspection and repair procedures recommended in the service instructions? • Achieve a system which operated normally and was free of internal and external leaks?

13. INSPECT, CHECK, TROUBLESHOOT, SERVICE AND REPAIR ENGINE COOLING SYSTEMS.

(EIT = 7 hrs., T = 3 hrs., L/S = 4 hrs.)
2 segments

(UNIT LEVEL 3)

INSPECT, CHECK, AND SERVICE ENGINE COOLING SYSTEMS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- **Given:**
  Drawings or other visual aids that illustrate the fins on an aircraft cylinder, airflow patterns through pressure baffles and fan-cooled helicopter engines, airflow patterns through augmentors and fluid flow within liquid cooling systems; a completely cowled and baffled air-cooled engine and the manufacturer's service instructions for this specific engine installation.

- **Performance:**
  The student will inspect, check and service the cooling system of the completely cowled and baffled engine. He will interpret information from the manufacturer's manual and describe the effects of excessive heat, cowl flaps, baffles, augmentors and fuel-air ratios.

- **Standard:**
  The inspection, servicing and description of operation will be in accordance with the manufacturer's service instructions. Correct nomenclature will be used as a part of all descriptions and explanations.

Key Points	*Feedback*
Airflow patterns.	**•What is meant by the term "pressure" baffle?** **•What is the purpose of fins on a cylinder?** **•How is the airflow directed and controlled so that heat transfer and dissipation takes place in all parts of the cylinder?** **•What is the purpose of an engine cowl flap?** **•What is the purpose of an exhaust augmentor?** **•What positive method of airflow may be used to circulate air through an air-cooled engine mounted in a helicopter?** **•What are the advantages and limitations to the use of liquid cooling for engines?** **•What liquids are used in the cooling systems of liquid cooled engines? How is the liquid cooled?**
Inspection of cooling systems.	**•What publications would a mechanic use as a guide to the proper inspection of an engine cooling system?** **•How are baffles usually attached to an engine?** **•What effect will loose or incorrectly installed baffles have on the cooling of the engine?** **•What is the effect of excessive heat in an engine? What precautions are necessary during ground operation of the engine?** **•How may incorrect fuel-air ratios and incorrect ignition timing affect cooling of an engine?**

Activities	*Check Items* **Did the student:**
Describe the airflow through: **a. A pressure baffled engine.** **b. An exhaust augmentor.** **c. A fan-cooled engine.** **d. A liquid cooling system.**	**•Correctly use and interpret information from the service manual?** **•Use correct nomenclature and terminology as a part of the description and explanation?** **•Follow procedure specified in the manual?**
Inspect, check and service the cooling system of a completely cowled and baffled engine.	**•Detect and correct conditions that did not comply with the tolerance and limits specified in the manual?**

TROUBLESHOOT AND REPAIR ENGINE COOLING SYSTEMS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational aircraft engine, provided with complete cowling and baffling; written operating instructions and the manufacturer's service manual, cowl flaps and oil cooler shutters.

- **Performance:**
  The student will operate the engine and record oil and cylinder head temperatures as they respond to changes in the cowl flap position, oil cooler shutter position, and fuel-air ratios. He will relate this information to the troubleshooting information appearing in the manufacturer's service manual and describe the corrective action that would be taken. He will remove and reinstall the cylinder head baffles and inter-cylinder baffles on the engine.

- **Standard:**
  Engine operation, removal and reinstallation of the baffles will be in accordance with the manufacturer's service manual. Interpretation of troubleshooting procedure will be without error. Correct nomenclature will be used throughout the explanations and descriptions.

Key Points	*Feedback*
Troubleshooting an air-cooled cooling system.	•How would a single improperly installed baffle on just one cylinder be detected by instrument indications? •What instrument indication would give the first indication of incorrect fuel-air ratios? •What engine operational check would probably indicate faulty ignition timing? Explain how ignition timing is related to engine cooling. •If the adjustment of cowl flap and oil cooler rigging is not correct, how will engine cooling be affected? •What publication would a mechanic use as a guide when troubleshooting the cooling system of an engine? •How critical is the fit and position of an engine baffle? •If the paint is burned from a portion of the cylinder head, what is probably the fault?
Engine operation.	•What is the effect of prolonged ground operation on the cooling of an air-cooled engine? •Where are instructions available to guide a mechanic during ground operation of an engine? •What instruments are of particular importance when attempting to troubleshoot a cooling system problem?

Activities	*Check Items*
	Did the student:
Ground operate the engine, varying cowl flap position and fuel-air ratios. Record temperature indications. Interpret troubleshooting charts from the manufacturer's manual. Remove and reinstall cylinder baffles.	•Use and correctly interpret the manual? •Exercise safety precautions? •Accurately and concisely record temperature? •Follow the procedures specified and achieve return-to-service standards?

14. REPAIR ENGINE COOLING SYSTEM COMPONENTS. (EIT = 3 hrs., T = ½ hr., L/S = 2½ hrs.) 1 segment

(UNIT LEVEL 2)

REPAIR BAFFLES AND REPROFILE CYLINDER FINS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Typical samples of cracked and damaged cylinder head and inter-cylinder baffles, scrapped air-cooled cylinders, and the manufacturer's service and parts manuals.

- Performance:
  The student will identify those sample baffles that are repairable and will stop-drill and make riveted repairs as specified in the service manual. He will identify those baffles requiring welded repairs and determine the part number of the baffle by reference to the manufacturer's parts catalogue. He will profile one cylinder fin.

- Standard:
  The baffles and cylinder need not meet return-to-flight standards. The procedures, limits and tolerances specified in the manual will be adhered to for all activities.

Key Points	*Feedback*	*Activities*	*Check Items*
			Did the student:
Materials used in baffles.	**•Why is aluminum used for many deeply formed and drawn baffles?** **•What is the effect of cuts, scratches and notches in the baffles?** **•If an aluminum baffle is attached to the engine by means of a steel bracket, what method is used to attach the steel bracket to the baffle?** **•What kinds of materials are used to act as chafing strips between the baffles and the engine and cowling?**	**Repair a damaged baffle by stop-drilling and making a riveted repair.** **Select a welded baffle and identify the part number in a parts catalogue.** **Re-contour a broken fin on an aircraft engine cylinder.**	**•Use and correctly interpret information contained in the manufacturer's service manual?** **•Correctly use tools and follow specified procedure?** **•Correctly identify the part number?** **•Follow the procedure specified; use tools as recommended and observe the limits and tolerances specified in the manufacturer's manual?**
Repair of baffles and fins.	**•What reference publications will guide a mechanic when making repairs to baffles and cylinder fins?** **•How would a mechanic determine the maximum amount of cooling fin that could be removed when re-profiling?** **•Describe how stop-drilling may serve to prevent further cracking of a baffle.** **•What economics must a mechanic consider when he recommends extensive repairs to baffles?**		

ENGINE EXHAUST SYSTEMS

15. INSPECT, CHECK, TROUBLESHOOT, SERVICE, AND REPAIR ENGINE EXHAUST SYSTEMS. (EIT = 13 hrs., T = 6 hrs., L/S = 7 hrs.)

4 segments

(UNIT LEVEL 3)

INSPECT, REMOVE, REPLACE, ADJUST, AND REPAIR JOINTS IN THE EXHAUST SYSTEM.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  An aircraft engine with a complete exhaust manifold system, spare replacement sections of manifold, the service manual for the specific engine and appropriate tools and equipment to inspect an exhaust manifold.

- Performance:
  The student will inspect the exhaust manifold and make a written record of condition. He will remove, replace, and adjust a replacement section of manifold as directed by the instructor. He will interpret information from the service manual and describe the repairs permitted in the exhaust system.

- Standard:
  The inspection, removal, reinstallation, and adjustment of the manifold will be in accordance with the procedures specified in the manual. Correct terminology will be used as a part of the description of repairs.

Key Points	*Feedback*
Exhaust manifold joints.	• Why must slip-joints or expansion-joints be provided in an exhaust manifold? • What results if a slip-joint or ball joint in a manifold freezes or will not slip? • What causes the ball joints to seize or freeze? • What is the purpose of a bellows in an exhaust manifold?
Removal and reinstallation of exhaust manifolds.	• What are some of the methods used to free a frozen or seized joint in a manifold? • What reference manual would be used to determine the correct hardware and fasteners to be used for installation of a manifold? • What tests can be made to determine whether an exhaust manifold clamp is correctly torqued?
Repair of exhaust manifolds.	• Where would a mechanic find information which described the repairs approved for exhaust manifolds? • What kind of welding equipment is generally used to repair stainless steel exhaust manifolds?

Activities	*Check Items* Did the student:
Inspect an exhaust system and make a written record of condition.	• Use and correctly interpret information available in the service manual? • Detect cracks, misalignment and other defects?
Remove and reinstall an exhaust manifold.	• Follow the procedures specified in the manual? • Use correct hardware and observe required torques?
Describe approved exhaust manifold repairs.	• Use correct nomenclature and terminology as a part of the description? • Identify the limitations applicable to exhaust manifold repairs?

INSPECT, REMOVE AND TEST EXHAUST HEATERS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An exhaust manifold incorporating a cabin or carburetor heater, the manufacturer's service instructions applicable to that specific manifold and heat exchanger assembly.

- Performance:
  The student will inspect the heater and muffs, test the condition of the heat exchanger and make a written record describing the condition of the heater.

- **Standard:**
The inspection, testing and reinstallation will be in accordance with the procedures specified in the service manual. The heater itself need not meet the return-to-service standards. The written record will accurately reflect the condition of the heater.

Key Points	*Feedback*
Purpose of exhaust heaters.	• Describe how an exhaust manifold heater may be used to supply both cabin heat and heat for the carburetor. • What hazard could result from a leak in the manifold beneath the heater muff? • If the heated air supplied to the carburetor is contaminated by a leak from the exhaust, how would the engine power be affected?
Inspection of exhaust heaters.	• What reference publication would contain information specifying the frequence of heater inspection? • What is meant if the inspection procedure recommends that the manifold heater be checked for "blisters, distortion, or local hot spots"? • What inspection tools are generally used to assist a mechanic in the inspection of an exhaust heater?
Testing of manifold heaters.	• Describe how exhaust manifold heaters may be tested using compressed air and immersion in water. • How may an exhaust manifold be sealed prior to accomplishing an air pressure test? • What publication would contain information describing the recommended testing procedures?
Repairs to heaters and muffs.	• What factors must be considered when deciding whether a heater shroud should be repaired or replaced with a new unit? • What reference publication will provide information regarding repairs to exhaust heaters? • Why are carbon monoxide checks sometimes required in the cabin following repairs or alterations to the exhaust heater system? • How is the airflow controlled from the exhaust heater to the cabin of the airplane?

Activities	*Check Items*
	Did the student:
Inspect the heater and muff assembly.	• Use and correctly interpret the reference information?
Test the heater assembly.	• Follow the recommended procedures?
Make a written record of condition.	• Use correct nomenclature and terminology?
	• Correctly judge condition following inspection and testing?

IDENTIFY, INSPECT AND DESCRIBE THE OPERATION OF TURBO-SUPERCHARGERS AND TURBO-COMPOUND ENGINES.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
Charts, diagrams or other suitable reference information; components of the turbo-supercharger and turbocompound systems and the service information applicable to one specific system.

- **Performance:**
The student will distinguish between turbo-supercharging and turbo-compounding of engines. He will describe the operation of both systems and the inspection procedure that would apply to one specific system of turbo-supercharging.

- **Standard:**
Correct nomenclature and terminology will be a part of all descriptions and explanations. The inspection procedures will be interpreted without error.

Key Points	*Feedback*
Power recovery turbines.	• As turbines are used in both turbo-supercharging and turbocompounding, what is the difference between the two systems? • What method of coupling is used between the turbine and the crankshaft of a compounded engine?

	•What force or energy is used to drive the turbine in each system? •What publication contains information describing the location, operation, lubrication, etc., of the turbines? •What are the advantages and limitations applicable to each system?
Inspection of power recovery turbines.	•Where would a mechanic locate information describing the repair and inspection of turbines? •What factors limit the repairs that may be made to a turbine?

Activities	*Check Items* Did the student:
Distinguish between and describe the operation of turbo-supercharging and turbocompounding. Describe the inspection procedure to be followed to inspect a turbo-supercharger.	•Use and correctly interpret the reference information? •Use correct nomenclature and terminology? •Adequately describe the operation and inspection procedure?

DESCRIBE THE OPERATION AND INSPECTION OF JET ENGINE THRUST REVERSERS AND NOISE SUPPRESSORS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  Charts, drawings, diagrams or other visual aids and reference information illustrating and describing the jet engine exhaust nozzle, thrust reversers and noise suppression devices.

- Performance:
  The student will interpret the reference information and describe the operation and inspection procedures applicable to the nozzles, reversers and silencers of jet engines.

- Standard:
  Reference information will be correctly interpreted. Correct nomenclature and terminology will be used as a part of all descriptions and explanations.

Key Points	*Feedback*
Types of exhaust nozzles.	•Where would a mechanic find information describing the exhaust system of a specific jet engine? •What is the difference between a convergent and a convergent-divergent exhaust nozzle? •Which type of exhaust nozzle is used for subsonic gas flow?
Thrust reversers.	•What are the advantages of thrust reversal over drag chutes? •Distinguish between a mechanical-blockage and an aerodynamic thrust reverser. •What safety device is incorporated into the thrust reversing system to prevent inadvertent reversal during flight? •How is thrust reversing system incorporated into a high bypass fan type engine?
Noise suppressors.	•Where does noise originate within a jet engine, and how does the noise produced by the compressor compare with exhaust noise? •Does high frequency or low frequency sound travel the greater distance? •How does exhaust noise vary with changes in thrust and airflow?

Activities	*Check Items* Did the student:
Interpret the reference information and use visual aids to illustrate and describe: a. Operation of jet engine nozzles, reversers, and silencers. b. The inspection procedures applicable to nozzles, reversers and silencers.	•Use and correctly interpret the information? •Use correct nomenclature and terminology as a part of the descriptions and explanations?

16. REPAIR ENGINE EXHAUST SYSTEM COMPONENTS. (EIT = 4 hrs., T = 2 hrs., L/S = 2 hrs.) 1 segment

(UNIT LEVEL 2)

RECOGNIZE MATERIALS USED IN EXHAUST SYSTEM COMPONENTS AND DESCRIBE REPAIR PROCEDURES.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Ten samples of exhaust system components from both piston and jet engines and appropriate reference information describing the repair of exhaust components.

- **Performance:**
  The student will identify five exhaust system components by name and use appropriate reference information as a means of determining the materials used in the component. He will interpret the information describing the repair of one exhaust system component.

- **Standard:**
  The student will correctly identify five of the ten sample parts by name. He will correctly interpret and describe the repair of one component.

Key Points	*Feedback*
Exhaust system materials.	• Why is stainless steel often used in the manufacture of engine exhaust systems? • Why are some exhaust system components provided with a ceramic coating? • Describe how parts may be metallized. • What materials should be used in the bolts, nuts and hardware used to mount exhaust manifolds?
Cleaning and inspection.	• Describe a method for cleaning stainless steel prior to repair by welding. • What technique may be used to clean ceramic coated exhaust system parts? • What methods are effective in detecting cracks in stainless steel exhaust stacks? • What are the causes for cracks between the adjacent cylinder pipes on a collector ring? • What inspection should be made of the expansion joints in an exhaust system? • What reference information should a mechanic use when cleaning and inspecting an exhaust manifold?
Repair of exhaust components.	• What hazard is involved in marking a stainless steel component with a common lead pencil? • What are the limitations to the use of oxy-acetylene gas welding when repairing exhaust system components? • What are the advantages to the use of inert-arc welding? • What procedures are effective in compensating for the expansion and contraction of the components during welding?

Activities	*Check Items*
	Did the student:
Identify five exhaust system components by name. Describe the repair of one exhaust system component.	• Select components and correctly use the reference information as a means to identify the component? • Correctly interpret repair information contained in the manual? • Use correct nomenclature and terminology as a part of the description and explanation?

17. OVERHAUL MAGNETO AND IGNITION HARNESS.

(EIT = 30 hrs., T = 15 hrs., L/S = 15 hrs.)
5 segments

(UNIT LEVEL 2)

DISASSEMBLE, IDENTIFY COMPONENTS, AND REASSEMBLE A MAGNETO.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  A complete magneto (not necessarily capable of operation) including a rotating magnet and bearings, main magneto housing with pole pieces, a coil, cam and breaker assembly, condenser, distributor rotor; written reference information applicable to the specific magneto; charts, diagrams or similar visual aids which will identify the components of the magneto and an unlabeled drawing or diagram of the magneto.

- Performance:
  The student will disassemble the magneto, identify the components, describe the materials and design features, label the drawing and reassemble the magneto.

- Standard:
  The disassembly and reassembly will be accomplished as recommended in the written instructions. The reassembled magneto will have all bolts and other assembly devices correctly installed, torqued and safetied. Correct nomenclature will be used to identify and describe the components and label the drawing.

Key Points	*Feedback*
Magneto description.	• What is meant if a magneto is described as a "high tension" magneto? • What is the difference between "dual ignition" and a "dual magneto"? • If a magneto identification plate indicates that the magneto is "right" rotation, how must the drive be viewed to determine the direction of rotation?
Magneto components.	• Why is the magneto housing ventilated? • How are the outer bearing races for the bearings of the rotating magnet usually attached to the magneto housing? • What publication would contain instructions specifying the sequence and procedure for disassembling, overhauling and reassembling a magneto? • What material is generally used in the construction of a rotating magnet? • Why are the pole pieces in the main magneto housing generally laminated? • How is the cam that opens and closes the breaker point assembly attached to the rotating magnet shaft? • What precautions should be observed when the rotating magnet is removed from the magneto? • Why should a mechanic avoid the use of force when disassembling or reassembling the components of a magneto? • From what material is the breaker cam follower usually manufactured? • Why would lack of lubrication or a rough surface on the cam cause rapid wear of the cam follower? • What provision in the design of the breaker assembly permits adjustment of the breaker point clearance? • Why are the breaker assembly and condenser usually replaced as a unit?

Activities	*Check Items* Did the student:
Disassemble the magneto.	• Follow the procedures and use the tools as recommended in the written instructions?
Identify the components, describe the materials and design features.	• Correctly interpret information contained in the reference information? • Use correct nomenclature and terminology during the description?
Reassemble the magneto.	• Correctly install, torque and safety all components and attaching devices?

INSPECT AND SELECT SERVICEABLE MAGNETO BREAKER ASSEMBLIES.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
A display of five typical magneto breaker assemblies, two of which are not serviceable; a magneto of the type using the breaker assemblies represented in the display; a manufacturer's manual describing the installation and adjustment of breaker point clearances; recommended tools and equipment.

- **Performance:**
The student will inspect the breaker assemblies and select a serviceable assembly. He will install and adjust the breaker assembly in the magneto.

- **Standard:**
A serviceable breaker assembly must be selected. Installation procedures will be followed and tools will be used as recommended. The installed breaker assembly will meet the tolerances specified in the manual.

Key Points	*Feedback*
Types of breaker assemblies.	•What recognizable feature permits the identification of a pivot type breaker assembly? •Why do the majority of magnetos now incorporate a pivotless type breaker?
Materials used in points.	•What is the advantage of a platinum point in a magneto breaker assembly? •Why are many of the breaker points made of tungsten?
Inspection of breaker assemblies.	•What is the appearance of a breaker point that is often described as burned and pitted? •If the surface finish of a breaker point has a frosted appearance, what does the mechanic know about the condition of the points and condenser? •If there is a peak on one point of the breaker and a cavity in the opposing point, what action should be taken? •How is breaker spring tension checked? •How is a judgment of the acceptable limits of cam follower wear made?
Inspection of breaker cams.	•Why do some breaker cams have more than two lobes? •If the magneto incorporates a compensated cam, how is the cam lobe for each cylinder identified? •How could a cam be checked for concentricity on the shaft?
Installation and adjustment of breaker assemblies.	•Where would a mechanic find information describing the installation and adjustment of breaker assemblies? •If the breaker points require a specific clearance adjustment, what tool is used to measure the point clearance? •How is the condenser mounted and electrically connected to the breaker assembly? •How is the cam follower lubricated?

Activities	*Check Items* Did the student:
Select a serviceable breaker assembly.	•Properly determine that the assembly selected was serviceable?
Check the breaker cam and breaker assembly housing.	•Inspect the breaker housing and cam as recommended in the manual?
Install and adjust the breaker point assembly.	•Follow the procedures and use the tools specified?
Check the breaker spring tension.	•Correctly interpret information and make the check of tension?
	•Maintain a standard of workmanship within the specified tolerances?

INTERNALLY TIME A MAGNETO.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- **Given:**
A magneto, manufacturer's service information and tools and equipment necessary to check internal timing and establish "E" gap position.

- **Performance:**
The student will disassemble and reassemble the magneto, maintaining the internal timing and verifying the "E" gap position.

- **Standard:**
  Disassembly and reassembly will be in accordance with the procedures specified in the manual. Tools will be correctly used and tolerances specified will be maintained.

Key Points	*Feedback*
Magneto electrical theory.	• Explain why a magneto may be described as an AC generator. • Explain the flux circuit that is established as the rotating magnet rotates within the pole pieces or pole shoes. • Explain the relationship of the magnetic flux, core of the coil, primary winding, points, condenser and magneto switch. • Describe the action of the secondary circuit of a magneto. • How is current flow established in the secondary circuit?
Internal timing of a magneto.	• What should be the position of the rotating magnet when the breaker points open? • What is implied when a mechanic describes an "E" gap of a magneto? • Why are there marks to indicate the position of a cam on the rotating magnet? • Why are the mating teeth of the rotating magnet drive gear marked to indicate the correct meshing position with the distributor drive gear? • Why do some magnetos have a step cut cam? • Why do some magnetos have timing marks scribed in the distributor gear and main magneto housing? • Where would a mechanic find information describing the procedure to be followed in bench timing a magneto with a compensated cam?

Activities	*Check Items* Did the student:
Disassemble and reassemble a magneto maintaining internal timing.	• Follow the procedures and use the tools as recommended in the manual? • Correctly interpret reference information and make required adjustments?
Verify or check "E" gap.	• Achieve the tolerance specified?

INSTALL HIGH TENSION LEADS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Examples of distributor blocks, shielded manifolds, flexible shielding and associated connectors; lengths of high tension ignition wire; manufacturer's manuals or written service information describing the inspection, testing and installation of replacement wiring in the ignition manifold; recommended tools and equipment.

- **Performance:**
  The student will inspect leads and use test equipment as a means of determining the serviceability of ignition wiring. He will install replacement wiring in an ignition manifold.

- **Standard:**
  Information will be correctly interpreted. The recommended procedures will be followed and tools corecetly used. The completed harness will meet the specifications established in the reference specifications.

Key Points	*Feedback*
Ignition cable.	• What factors determine whether the ignition cable is made with a copper or stainless steel conductor? • Why do some ignition cables have different diameters? • What is the advantage of an ignition cable that incorporates an integral shielding?
Distributor blocks and shielded manifolds.	• What methods may be used to secure the ignition cable in the distributor block? • Where would a mechanic find information describing the attachment of cables and the installation of cables into the manifolds? • Why are ignition harnesses shielded?
Inspection and testing of ignition harness.	• What are some of the causes for breakdown of the insulation of a shielded ignition cable? • What is the effect of high altitude on the operation of a shielded ignition cable?

	• What publication would contain information describing the inspection and testing of an ignition harness?
Installation of replacement ignition cable.	• How would a mechanic determine the required length of a replacement cable? • What procedure should be followed when installing a replacement cable into a separate metal manifold? • What procedure and equipment is necessary to attach new fittings to an ignition lead that has integral shielding?

Activities	*Check Items*
	Did the student:
Inspect and test an ignition harness. **Install a replacement ignition lead in a distributor block and harness.**	• Correctly interpret the information contained in the manual or reference publications? • Follow the recommended procedure and correctly use tools? • Achieve and maintain a standard of workmanship within the specified tolerances?

ASSEMBLE, OPERATE AND DISASSEMBLE AN IMPULSE COUPLING ON A MAGNETO.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- Given:

  An operational magneto; a disassembled impulse coupling that was designed for use on the magneto; manufacturer's service information describing the assembly, operation and disassembly of the impulse coupling and magneto; recommended tools and a means of driving the magneto as a test of the completed assembly.

- Performance:

  The student will assemble the impulse coupling. He will mount the impulse onto the magneto drive shaft and check the operation of the assembly. He will remove and disassemble the impulse coupling following the operational check.

- Standard:

  Information contained in the reference publications will be correctly interpreted. Recommended procedures will be followed. Tools and equipment will be properly used and cared for. The disassembled impulse coupling will be stored in a manner that will minimize damage and loss of parts.

Key Points	*Feedback*
Impulse couplings.	• What is the purpose of an impulse coupling? • What device within the coupling provides the "snap" or high rotational speed to the magneto drive? • What is the function of the flyweights in an impulse coupling?
Installation, inspection and operational checking of an impulse coupling.	• How would a broken spring in an impulse coupling effect the starting of an engine? • How would a broken spring effect the operation of the engine after the engine had been started? • Where would a mechanic find information specifying the inspection and limits of wear on an impulse coupling?

Activities	*Check Items*
	Did the student:
Assemble the impulse coupling and install on the magneto drive. **Operationally check the impulse coupling.** **Disassemble the impulse coupling.**	• Correctly interpret reference information and follow correct procedures? • Correctly use tools and observe safety precautions? • Store parts to avoid damage and minimize loss?

18. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR RECIPROCATING AND TURBINE ENGINE IGNITION SYSTEMS. (EIT = 32 hrs., T = 12 hrs., L/S = 20 hrs.) 7 segments

(UNIT LEVEL 3)

INSPECT, CHECK, TROUBLESHOOT, REMOVE AND REINSTALL WIRING TO AN IGNITION SWITCH.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:

  An ignition switch installed in an airplane or test stand, and connected to control the magnetos of an operational engine; a drawing or diagram illustrating the switch electrical circuit and suitable equipment for checking circuit continuity.

- **Performance:**
  The student will inspect the ignition switch circuitry and check operation of the switch by operating the engine. The instructor will introduce a fault into the switch circuit and the student will troubleshoot the fault and remove and reinstall wiring as a means of correcting the fault.

- **Standard:**
  The drawing or diagram will be correctly interpreted and used in the analysis of the fault. Electrical test equipment will be correctly used and cared for. The ignition switch circuit, following correction of the fault, will be capable of operating as it was designed to operate. The procedure followed in the accomplishment of this task shall not impose a safety hazard.

Key Points	*Feedback*
Types of ignition switches.	•What switch positions are common to the ignition switch used on a single engine airplane? •How may the ignition switch of a twin or multi-engined airplane differ from the switch used on a single engine airplane? •Why may some ignition switches incorporate a "start" position in addition to the "off-right-left and both on" positions?
Ignition switch circuits.	•Does a battery ignition switch open, close or ground the primary ignition circuit? •When a magneto switch is positioned in the "off" position, what is the effect of the switch on the primary circuits of the magnetos? •What will be the effect of crossing the magneto switch wires between the left and right magnetos of the engine?
Troubleshooting ignition switch circuits.	•What will result if the wire between a magneto and the switch becomes disconnected? •What condition will result if the wire connected to the magneto switch ground becomes disconnected? •What publication would a mechanic use to determine whether the breaker housing of a magneto incorporated an "automatic" grounding spring? •If an ohmmeter is connected to the "L" contact on the ignition switch, what indication is normal when the switch is positioned to the "off" position?
Safety considerations.	•What precautions should be taken and what warnings should be posted when the ignition switch wires are disconnected from the magnetos?

Activities	*Check Items*
	Did the student:
Operate the engine, inspect and check operation of the ignition switch.	•Use and correctly interpret the diagrams of the ignition switch circuit?
Troubleshoot an introduced fault in the circuit.	•Correctly analyze the symptoms and isolate the fault?
Correct the fault and restore the switch circuit to normal operation.	•Take correct action and accomplish work in such a manner that the system operated normally and did not constitute a hazard?

USE AN IGNITION HARNESS TESTER TO IDENTIFY A SHORTED IGNITION LEAD ON AN ENGINE.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational engine with one shorted ignition lead, an ignition harness tester, written information describing the use and operation of the harness tester.

- **Performance:**
  The student will operate the engine and identify the symptoms associated with a shorted ignition lead. He will use the ignition harness tester to identify a shorted lead.

- **Standard:**
  Operation of the engine and tester will be in accordance with the written instructions. The task will be accomplished without imposing unnecessary safety hazards. Written information and test results will be correctly interpreted.

Key Points	*Feedback*
Ignition lead faults.	•At what location on the ignition lead is a short most likely?

	•What are the advantages and limitations to a radio shielded ignition lead? •How will water and other liquids affect an ignition lead?
Ignition harness testers.	•What safety precautions should be observed when using a high tension ignition harness tester? •Where would a mechanic find information describing the correct use of the tester? •In general, what faults may be detected through the use of a harness tester? •Why must a lead under test be disconnected from the magneto and spark plug?

Activities	*Check Items* Did the student:
Operate the engine, recognize and identify the symptoms of a shorted ignition lead.	•Observe safety precautions and follow correct operating procedures? •Correctly identify symptom and record location of malfunction by operating on left and right magneto?
Use harness tester and identify the shorted lead.	•Correctly interpret written information and test results? •Correctly isolate faulty lead?

INSTALL, INSPECT, OPERATE, TROUBLESHOOT AND REPAIR AN IGNITION BOOSTER SYSTEM.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  A magneto that incorporates provisions for a booster or induction vibrator, reference information that describes the inspection, operation and procedure for troubleshooting the specific booster system, tools and equipment as recommended by the reference manual, and the induction vibrator or booster coil.

- Performance:
  The student will install the magneto on a suitable magneto test bench, connect the boost system and check operation. He will inspect the system after the instructor has introduced a fault into the booster system and make repairs to restore the system to normal operation.

- Standard:
  All work will be accomplished in accordance with the reference information. Information will be correctly interpreted. Following troubleshooting and repair, the system will operate within the tolerances specified in the reference manual.

Key Points	*Feedback*
Types of booster systems.	•If the starting booster system utilizes a separate booster coil, how is the high tension current distributed to the engine for starting? •If an induction vibrator excites the coil of the magneto, how is starting current delivered to the engine? •What methods may be incorporated to retard the high tension current used for starting? •What is the source of power for the operation of a booster system?
Installation, operation, troubleshooting, and repair of booster systems.	•Where would a mechanic find information describing the servicing of a booster system? •If the points in an induction vibrator or booster coil stuck closed, what would happen? •How is the booster system "turned on" or supplied with power during the starting of the engine?

Activities	*Check Items* Did the student:
Install the system and check operation.	•Correctly interpret the written information?
Troubleshoot a fault in the system and restore to normal operation.	•Follow the recommended procedures, correctly use tools and analyze faults? •Achieve normal system operation following repair?

REMOVE, INSPECT, RECONDITION, TEST AND REINSTALL SPARK PLUGS.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  An operational reciprocating aircraft engine; a random display or aircraft spark plugs of the shielded type, long reach, short reach, massive and fine wire electrode, hot plug, cold plug, etc., spark plug specifications applicable to the specific engine and reference information and tools necessary to remove, inspect, service and test spark plugs.

- Performance:
  The student will interpret the specifications and select spark plugs that are approved for installation in the specified engine. He will remove the spark plugs previously installed in the engine, inspect, recondition, and test them, then reinstall them and check engine operation.

- Standard:
  The task will be accomplished in full accordance with the reference instructions. The identification of spark plugs to be used will be without error. Reconditioned spark plugs will test and operate within specified tolerances. The installation of the spark plugs will be accomplished at a return-to-service standard.

Key Points	*Feedback*
Identification of spark plugs.	• What is the difference between a shielded and an unshielded spark plug? • How does a long reach plug differ from a short reach plug? • What is the difference between a hot and a cold spark plug?
Installation and removal.	• What damage may result from over-torquing a spark plug? • What should a mechanic do with a spark plug that has been dropped? • What may result if a long reach plug is installed in a cylinder that was designed for a short reach plug? • How is a spark plug installed with a thermocouple? • What damage may result from the use of an incorrect tool? • What reference publication specifies the correct spark plug installation torque values? • What kind of lubricant may be used on spark plug threads before installation? • How important is the condition of the gasket to be used under the spark plug and how could a gasket be annealed? • What tools and procedures should be used when removing the spark plug leads?
Inspection and testing.	• How may the condition of the spark plug electrodes be used to indicate engine operating conditions, i.e., what trouble is indicated by excessive carbon formations on the spark plug electrodes? • What reference information should a mechanic use for testing a spark plug? • How would a mechanic determine the correct spark plug gap when adjusting the gap of the electrodes?
Operational checking of spark plugs.	• If a single spark plug of a typical aircraft engine is not firing, how could a mechanic determine the approximate location of the faulty plug? • When making a magneto check, in addition to engine roughness, approximately how much RPM drop should be expected from a single faulty spark plug?

Activities	*Check Items* Did the student:
Select spark plugs for a specified engine.	• Correctly interpret specifications and identify spark plugs by type, etc.?
Remove, inspect, recondition and test spark plugs from an engine.	• Follow the correct procedures, properly use tools and equipment?
Install spark plugs and check operation in engine.	• Achieve a standard which resulted in normal engine operation?

TIME MAGNETOS TO AN ENGINE.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational engine; two magnetos, at least one incorporating an impulse coupling, manufacturer's manual or written information describing the installation and timing of the magneto to the engine, tools and equipment as recommended in the reference information.
- **Performance:**
  The student will install and time magnetos and operate the engine.
- **Standard:**
  The work will be accomplished in accordance with the reference publications. Instructions will be interpreted without error. The completed installation will meet the tolerances specified in the manual or other written reference information.

Key Points	*Feedback*
Preparation of engine for magneto installation.	• Why must the engine be positioned on compression stroke? • What publication will contain information describing the installation and timing of magnetos to a specific model of engine? • How may the "top dead center" position of a number 1 piston be determined on an engine that has a propeller gear reduction? • If the back of the propeller flange on a direct drive engine is marked to indicate "TDC," what procedure is necessary to establish top dead center, compression stroke?
Position of magneto during installation.	• How could a mechanic determine when a magneto is in position to deliver a spark to the number 1 cylinder? • Explain why a magneto may be incorrectly timed even though the points are opening at the proper time. • Why are the distributors usually removed when a magneto is being timed to the engine?
Impulse couplings.	• Where would a mechanic find specific instructions detailing the timing procedure to be followed when timing a magneto with an impulse coupling? • What procedure may be employed to disengage or release the impulse so that the magneto may be timed?
Installation and timing.	• Assuming that top center position has been established, what is the purpose of a timing disc and pointer? • What procedure will prevent rotation of the magneto rotor while the magneto is being mounted on the engine? • What is the meaning of the term "staggered" timing? • Why is the tolerance permitted in timing of magnetos so critical, i.e., what damage may result from incorrectly timed magnetos? • What devices may be used to indicate the opening of the breaker points of the magneto? • If a magneto incorporates an automatic grounding spring at the primary switch lead connection, what procedure must be followed in the use of a timing light? • When connecting the switch leads to the magnetos, describe how a mechanic may identify the correct switch terminal for the left magneto.

Activities	*Check Items*
Position the engine to install the magnetos. Install and time the magnetos. Operate the engine.	Did the student: • Use and correctly interpret written information? • Follow the correct procedures and correctly use tools and equipment? • Achieve the specified accuracy? • Check and verify normal operation?

IDENTIFY, COMPARE AND INTERPRET IGNITION ANALYZER PATTERNS.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- Given:
  Diagrams illustrating eight different ignition analyzer patterns, reference information describing the operation of an ignition analyzer and illustrations of typical analyzer patterns.

- Performance:
  The student will identify, compare and interpret ignition analyzer patterns.

- Standard:
  At least four of the eight patterns will be correctly identified and interpreted.

Key Points	*Feedback*
Use of analyzers.	• What use has been made of ignition analyzers in trouble-shooting aircraft engines? • Where would a mechanic obtain information describing the operation and interpretation of analyzer patterns? • How is an analyzer timed to the engine?
Interpretation of patterns.	• What are the conclusive points of comparison that should be used when interpreting an analyzer pattern? • How reliable are the interpretations made by relatively inexperienced analyzer operators?

Activities	*Check Items* Did the student:
Identify and compare ignition analyzer patterns. Interpret the illustrated patterns and describe the probable fault.	• Recognize the similarities between the patterns? • Correctly interpret reference information? • Use correct nomenclature and terminology?

COMPARE AND DESCRIBE THE DIFFERENCES BETWEEN PISTON ENGINE AND TURBINE ENGINE IGNITION SYSTEMS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- Given:
  Schematic diagrams, drawings and suitable reference information describing the operation, servicing and repair of ignition systems for turbine engines, examples of turbine engine igniter plugs, and multiple completion essay statements.

- Performance:
  The student will complete ten statements comparing and describing the differences between piston engine and turbine engine ignition systems, and describing the removal, inspection and installation of turbine engine igniter plugs.

- Standard:
  At least seven statements will be correctly completed.

Key Points	*Feedback*
Turbine engine ignition systems.	• What is the energy source for a turbine engine ignition system? • Why doesn't the ignition system of a turbine engine operate continuously? • Why isn't each combustion chamber provided with a separate igniter plug? • Why isn't a distributor system necessary to the operation of a turbine engine ignition system? • What are the two types of igniter plugs used in turbine engines? • Why do turbine engine igniter plugs have relatively wider gaps than piston engine spark plugs? • Why do igniters have relatively little erosion with respect to total engine time? • Where would a mechanic find information describing the kind of igniter and the installation, inspection and servicing procedures applicable to a specific turbine engine?

Activities	*Check Items* Did the student:
Complete essay statements comparing piston and turbine engine ignition systems, and describing the removal, inspection and installation of turbine engine igniter plugs.	• Correctly interpret reference information? • Use correct nomenclature and terminology for the completion words?

19. REPAIR ENGINE IGNITION SYSTEM COMPONENTS. (EIT = 28 hrs., T = 14 hrs., L/S = 14 hr.) 4 segments

(UNIT LEVEL 2)

OPERATE AND TEST A MAGNETO ON A TEST BENCH.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  Two operational magnetos, one with a weak breaker spring and one with a weak charge in the rotating magnet; a test bench provided with a spark rack, varidrive and associated leads and test meters; manufacturer's manuals or equivalent written information.
- **Performance:**
  The student will operate and test both magnetos, identifying the fault in each magneto and demonstrating the effects of a weak breaker spring or low charge in the rotating magnet of the magneto.
- **Standard:**
  Test specifications, procedures and results will be correctly interpreted. Operations will be accomplished without damage to the tools, equipment or components.

Key Points	*Feedback*
Bench testing of magnetos.	• Where would a mechanic find information pertaining to the testing and operation of a magneto test bench? • What is meant by the term "coming-in speed" as applied to a magneto being tested? • How is the speed of the magneto test bench drive indicated with high speed operations? • What hazards may be associated with operating a magneto without a harness and spark rack?
Breaker spring tension.	• How is breaker spring tension measured? • How far should the breaker points be spread when measuring spring tension? • What damage may be done by pulling the breaker points past their normal travel? • What ignition malfunctions may be related to faulty breaker spring tension?
Charging of rotating magnets.	• What is the effect of a weak magnet charge? • How is the charge of the magnet measured? • How is low current in the primary winding of a coil related to output of the magneto?

Activities	*Check Items*
	Did the student:
Operate both magnetos on the test bench: a. Measure breaker spring tension. b. Measure primary current.	• Use and correctly interpret reference information? • Correctly use tools and apply tolerances and specifications?
Identify magneto fault.	• Correctly demonstrate symptoms of weak breaker springs and weak rotating magnet? • Correctly identify the fault in each magneto?

TEST AND JUDGE THE SERVICEABILITY OF CONDENSERS.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- **Given:**
  Three condensers of the type normally installed in a typical high tension aircraft magneto; a condenser tester and written information and specifications applicable to the use of the test equipment.
- **Performance:**
  The student will test the condensers and record the test results. He will compare the results with the condenser specifications and judge whether the condensers meet specifications.
- **Standard:**
  Operation of the test equipment will be in accordance with the written instructions. Tests will be accurate within the accuracy of the tester and the condensers will be judged according to specifications contained in the written information.

Key Points	*Feedback*
Condenser testers.	• Where would a mechanic find information describing the use of a specific model of test equipment? • Why may some instructions describe the condenser as a capacitor?

	• What is the relationship of resistance and capacitance in a condenser? • What hazard exists in the use of the tester and handling of a charged condenser? • How can a condenser be checked with an ohmmeter?
Interpretation of test results.	• What appearance of breaker points is associated with a faulty condenser? • What purpose does a condenser serve in the magneto circuit? • How would a mechanic determine the type of condenser required for a specific magneto? • What repair may be made to a condenser that fails on the capacitance or leakage test?

Activities	*Check Items*
	Did the student:
Use a tester to test the serviceability of condensers.	• Follow recommended procedures and obtain accurate test results? • Correctly interpret specifications? • Correctly judge serviceability of the condensers?

USE A COIL TESTER TO TEST IGNITION COILS.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A coil tester, written specifications and information pertaining to the operation of the test equipment and the interpretation of test results; a coil from a typical high tension aircraft magneto, a transformer coil from low tension ignition system and a booster coil; and specifications for each of the specific coils.

- Performance:
  The student will test each of the coils for "opens," "shorts," and compliance with the manufacturer's specifications.

- Standard:
  Each of the coils will be identified as a means of establishing the applicable specifications. Tests will be accomplished as recommended in the written information and will not impose a safety hazard or cause damage to the test equipment or components.

Key Points	*Feedback*
Coil testers.	• Where would a mechanic find information pertaining to the correct use and interpretation of test results obtained from a particular tester? • What safety considerations should be observed when using coil testers? • How is an ohmmeter often used as a tester for a coil? • How are primary coil leads identified? What features will usually identify the connections for the secondary output?
Interpretation of results.	• Why is the temperature of the coil a consideration when a coil is being tested? • What is a capacitance effect in a shielded ignition lead?

Activities	*Check Items*
	Did the student:
Test a coil from a high tension magneto, a low tension transformer coil and a booster coil for open or short circuits and for compliance with specifications.	• Follow recommended procedures and obtain accurate test results? • Correctly interpret and apply specifications and tolerances to test readings?

DEMONSTRATE THE EFFECT OF FAULTS IN AN IGNITION LEAD AND CORRECT THE FAULT.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  An operational magneto mounted on a test bench that is equipped with an adjustable spark rack and varidrive; an ignition harness which has a single shorted lead and two or more open leads; replacement ignition leads or lengths of ignition cable which may be used to repair the harness; written operating instructions.

- **Performance:**
  The student will operate the magneto and check for leads which are open and shorted. He will describe the effects of continued operation with these faults. He will replace the leads or repair the harness and test at sufficiently wide spark gaps to induce an open in the serviceable harness and demonstrate the effects of an open in the circuit.

- **Standard:**
  Correctly detect defective leads. Replacement leads and harness repairs will meet return-to-service standards. Operation of the test bench and ignition system will not exceed limits established by the instructor or cause damage to the components.

Key Points	*Feedback*
Troubleshooting of faults in ignition harnesses.	• What methods are used to prevent the entrance of moisture into an ignition harness? • If moisture has penetrated an ignition manifold, what repair procedure should be followed? • Will moisture in a manifold probably result in an open or a short in the manifold? • What is the effect of continued operation with an open in an ignition lead? • What is the effect of continued operation with a short in an ignition lead?
Replacement of ignition leads.	• If a short has occurred at the high tension contactor or "cigarette," what repair procedure should be followed? • What problem may result from using an ignition lead that is longer than required? • What procedure should be followed when replacing or reusing the elbows and coupling hardware from an old ignition harness?

Activities	*Check Items*
	Did the student:
Operate the magneto on a test bench and detect open and shorted ignition leads.	• Follow the written operating instructions? • Correctly identify the defective leads?
Describe the effects of continued operation with open and shorted leads.	• Use correct nomenclature and terminology as a part of the description?
Replace the defective leads and demonstrate the effect of wide spark gaps.	• Achieve a repaired harness that met with operational standards? • Demonstrate the effect of opens in the ignition harness?

20. INSTALL, CHECK, AND SERVICE ENGINE ELECTRICAL WIRING, CONTROLS, SWITCHES, INDICATORS, AND PROTECTIVE DEVICES.

(EIT = 38 hrs., T = 18.5 hrs., L/S = 19.5 hrs.)
6 segments

(UNIT LEVEL 3)

TYPES, PURPOSES, APPLICABILITY AND OPERATION OF ELECTRICAL FUSES, CIRCUIT BREAKERS, AND SWITCHES USED IN ENGINE ELECTRICAL CIRCUITS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information dealing with types of switches and circuit protectors used in engine electrical circuits, AC 43.13–1 or equivalent publication, and questions concerning switches and circuit protection devices used with engine electrical components.

- **Performance:**
  The student will write answers for 12 questions concerning purposes, applicability and operation of fuses, circuit breakers and switches used with aircraft engine electrical components. He will draw a wiring diagram showing the circuit for a reversible electric motor, such as is used to actuate cowl flaps or an oil cooler door, including type of switch used and how circuit breakers are used for the control circuit and the motor operation circuit.

- **Standard:**
  At least nine questions answered correctly in accordance with the information provided. Circuit diagram correctly drawn to show switch control for both directions of motor operation and circuit breakers for the motor and the control circuits.

Key Points	*Feedback*
Circuit protection for aircraft engine electrical circuits.	**•Why are engine electrical components protected by circuit breakers in the flight compartment area?** **•What is the primary purpose of the circuit protectors?** **•How do fuses and circuit breakers differ in their operation as circuit protectors?** **•What wire characteristic determines the size of fuse or circuit breaker to be used?**
Characteristics and uses of circuit breakers and fuses.	**•Why are fuses generally used only in insulated inserts when protecting higher voltages?** **•What rating should a circuit breaker have to protect #2 gauge wiring?** **•Should a circuit breaker open under extreme overload conditions even if held in?** **•Explain the difference between "tripfree" and "nontripfree" circuit breakers.** **•What precautions should be taken to prevent inadvertent closing of a circuit breaker which has been opened because work is being done on the circuit?**
Switches.	**•What is meant by the nominal rating of a switch?**
a. Nominal rating.	**•What nominal rated switch would be required for a 12 volt lamp with a continuous load current of 3.6 amperes?**
b. Arcing at opening of contacts.	**•What causes arcing at the contacts of a switch controlling a solenoid relay?** **•How can arcing be reduced?**
Types of switches.	**•Name several types of switches used in aircraft engine electrical systems.** **•Why is a relay used in conjunction with a switch for controlling heavy current devices?**
Switch designations.	**•What is meant by the designations: SPST, DPST, DPDT, and 3PST?** **•Explain what is meant by normally open and normally closed switch contacts and how these are usually indicated.** **•What is meant by "momentary" switch or switch position?**
Switches for reversible motors.	**•What types of control switches are used for reversible motor control?** **•What type of switches are usually used for limit switches in reversible motor control circuits?**

	• What purpose do the limit switches serve and where are they usually located?

SELECT AND INSTALL AIRCRAFT ELECTRICAL SWITCHES AND WIRING TO ENGINE ELECTRICAL COMPONENTS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- **Given:**
  Written information, AC 43.13–1 or equivalent publication, a mock-up with provisions for mounting components and switches, aircraft engine electrical components, assorted aircraft electrical wire and switches, a DC power supply, an AWG wire gauge and suitable electrical tools.

- **Performance:**
  The student will determine the current required for an engine electrical starter, use an AWG chart to select wire of adequate size for 1 volt drop, and on the mock-up, connect the starter to a solenoid relay. He will install a suitable switch and connect it to energize the solenoid coil of the relay.

- **Standard:**
  Switch and wire selection and installation will comply with specifications provided. The starter and relay will be correctly connected and will operate properly.

Key Points	*Feedback*
Determine current requirements.	• What kind of meter would be needed to measure the current used by a starter motor? • If the specifications give the power rating only, how is the current calculated?
Determine wire requirements for a specific installation.	• What information is needed to compute required current carrying capacity of the wire to be used for the engine starter motor? • What is the effect on heat dissipation of routing wires together in a bundle? • What effect on the wire requirements will use of the airplane structure as a ground return have?
Determine gauge of insulated electrical wire.	• What methods may be used to determine the gauge of solid and stranded electrical wire? • What measurement factor is the AWG wire gauge system based upon? • How is an AWG wire gauge used for stranded wire? • In aircraft engine wiring installations, how is each wire identified as to system and gauge?
Wiring procedures.	• Where are the procedures for wiring to be found? • How are wires routed when near fuel or hydraulic lines? • What are the rules on more than one splice in a bundle? • If chafing could occur, how should the wire be protected?
Electrical cable chart in AC 43.13–1.	• What is the primary use of the cable chart in AC 43.13–1? • What is the purpose of the three curves in the cable chart? • Why must the allowable voltage drop be known in order to determine required wire gauge for an installation?
Selecting aircraft switches.	• Which type of switch is best for motors and relay controlled components? • Which type of switch is suitable for engine ignition control?
Mounting of switches.	• In what position should toggle on-off switches be mounted? • If a switch controls the movement of flaps, doors or gears, how should it be mounted relative to movement being controlled? • How are switches prevented from turning in their mounting holes? • What determines how close a switch may be mounted relative to other components?
Connection wires to switches.	• What considerations should be taken as to clearance between wire connections? • Name several methods of connecting wires to switches and the advantages and disadvantages of each method.
Installation of open wiring.	• What are the requirements for securing open wiring in aircraft engine areas?

	• Why are these requirements more critical near turbine hot sections and exhaust areas? • If wires are cut or damaged, where can repair specifications be found? • Where open wires must go through the firewall, what precautions must be taken? • How is wiring in engine or nacelle areas routed to facilitate access to engine servicing and component replacement? • What precautions should be taken when wiring must be close to fuel, oil, or hydraulic lines?
Selecting suitable protective devices for electrical circuits.	• Why will a fuse or current limiter usually be more suitable to protect the main power wire for a starter motor or electrical hydraulic pump motor? • How is the current rating for the fuse determined? • Why will a circuit breaker usually be more suitable for solenoid relay control circuit or a fuel pump motor?

Activities	*Check Items* Did the student:
Select wire complying with AC 43.13–1 specifications for 1 volt drop, using AWG wire table to determine size, connect an aircraft engine electrical starter to a solenoid relay and to a power source through a fuse.	• Calculate current requirements for each component? • Use electrical cable chart in AC 43.13–1 to determine gauge of wire needed? • Use AWG wire gauge to measure gauge of stranded wire? • Select a switch suitable for the solenoid winding current rating?
Select and install a switch on the mock-up, connect it with wire of selected size to control the solenoid relay.	• Drill holes and mount the switches with proper spacing and orientation? • Use an approved method of connecting wires to switches?
Connect switch to the power supply through a circuit breaker.	• Select a fuse of suitable current rating for the wire size? • Plan wire length to permit securing to mock-up by clamps? • Select a circuit breaker of suitable rating for the control wire size? • Check the solenoid relay and engine starter. motor for proper operation?

INSTALLATION REQUIREMENTS AND CHARACTERISTICS FOR AIRCRAFT ELECTRICAL WIRING SYSTEMS AND JUNCTION BOXES.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information, AC 43.13–1 or equivalent publication, questions with multiple choice answers.

- **Performance:**
  The student will select answers to 14 questions pertaining to the characteristics of single-wire electrical systems, the strength requirements for electrical cable terminals, the purpose, applicability, and use of terminal strips, installation requirements for junction boxes in areas around engines or in nacelle areas for powerplant use, and the criteria for selecting aluminum or copper wire, especially for engine electrical components where current requirements are large.

- **Standard:**
  Select correct answers for at least 10 questions.

Key Points	*Feedback*
Single-wire systems.	• What serves as the return path for a single-wire system? • How is the ground return path checked for integrity across the engine firewall? • How are electrical components connected for ground return when mounted on engine support members?
Electrical wire tables and AWG wire sizes.	• Compute the voltage drop for a #14 copper cable 40 feet long to carry 6.5 amperes. • Where can the AWG wire size information be found? • Why is a higher voltage drop allowed for intermittent than for continuous operation?

Aluminum vs. copper wire.	What gauge of aluminum wire will be required to replace #0 gauge copper wire? Why is aluminum wire often used for heavy current circuits such as generator output?
Junction boxes. **a. Construction and mounting.**	Why should engine electrical junction boxes be mounted on structural members? What material should be used for a junction box when fireproofing is necessary? How should the cover side of a junction box face in an engine area and why?
b. Internal arrangement.	Why is it important to provide adequate space in a junction box? What should be provided when electrical clearances are marginal?
c. Wiring.	What are the requirements for lacing and clamping cables inside a junction box? What type of lacing is permitted in engine area junction boxes? What added requirements are provided to protect wiring in junction boxes located in engine areas ahead of the firewall? How is wiring protected against chafing at entrance openings?
d. Drain holes.	What maintenance should be provided for drain holes?
Terminal strips. **a. Barriers.**	What purposes do the barriers serve?
b. Terminal studs.	Why is it important that studs be checked for tightness and for provision to prevent rotation before installing lugs? What is the maximum number of terminals per stud?
c. Terminal hardware.	Where is a guide to terminal hardware mounting to be found? What is meant by terminal protection? Why is it desirable to have at least one spare terminal stud in each strip?

Shielding wiring and equipment. **a. Purpose.**	What types of circuits require shielding to prevent radiation of interference? What types of circuits require shielding to prevent picking up interference?
b. Methods.	Name at least two methods of providing shielding for wires in engine areas. How is the shielding grounded in areas adjacent to engines?
Cable terminals. **a. Wire preparation.**	When stripping insulation, how many strands of wire may be cut on #10 copper wire and on #6 aluminum wire? Name four disadvantages of using solder for terminal attachment. Why are crimped terminals preferable in engine electrical wiring, especially around turbine engines? What is the purpose of inspection holes in terminal lugs?
b. Cable terminal strength requirements.	What is the requirement as to tensile strength for cable terminals?
Choice of terminals.	Why is it important to choose terminals designed for the specific size and kind of cable in use? When crimped lugs are installed, what are the special tool requirements? Why must crimped lugs be used with aluminum cable and what special compound must be used to prevent corrosion?

INSTALL ELECTRICAL TERMINALS, SPLICES AND BONDING JUMPERS, AND IDENTIFY AIRCRAFT ELECTRICAL CABLES.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  AC 43.13-1 or equivalent publication, manufacturer's instructions dealing with electrical terminals, assorted samples of aircraft wire and cable, terminals, splices, sleeving, bonding, jumpers, a mock-up with aircraft engine electrical components requiring bonding, two junction boxes connected by a conduit, and appropriate tools and equipment for soldering, crimping and installing wiring.

- **Performance:**
  The student will install five soldered and ten crimped terminal lugs on aircraft cable, including two on aluminum cable; splice cables with five crimped splices; select and install five bonding jumpers for aircraft engine electrical components which require bonding. He will list identifying data for ten different aircraft engine electric cable samples and will install six electric wires in a conduit connecting two junction boxes on a mock-up.

- **Standard:**
  At least 80 percent of the terminals, splices and bonds will meet specifications in AC 43.13–1 or manufacturer's instructions. At least seven cable samples will be correctly identified. Wiring installed through conduit will meet specifications provided.

Key Points	*Feedback*
Selection of cable terminals.	• Why must sleeve size be correct for the size of cable being used?
a. Match cable size and type of metal.	• On color coded terminals, what does the color of the terminal sleeve indicate? • Why must the connector be of similar metal to the cable?
b. Type of lug.	• What determines the type of lug to be selected? • What are the dangers of haphazard selection of types of terminals? • Why are ring-tongue terminals almost universally used in aircraft, instead of spade terminals, especially around engine or nacelle areas?
c. Size of lug.	• What determines the sleeve size required at the wire end? What determines the terminal ring hole size? • What are the hazards in selecting oversize lugs at the wire end? At the connecting end?
Wire preparation.	• How is a wire stripping tool used? • Why is a stripping tool better than a knife for wire stripping?
Methods of attaching to wire or cable.	• What are the advantages of using crimped lugs instead of solder lugs, especially in engine areas? • What is the importance of using the correct crimping tool for a specific kind of lug? • Where can instructions be found for attaching soldered terminals? Crimped terminals?
Special precautions.	• Why must special crimping tools be used for aluminum terminals?
a. Aluminum terminals.	• Why is a special paste specified for aluminum terminals?
b. Insulating sleeves.	• When terminals are not pre-insulated, how is insulating sleeving installed?
Splicing wire or cable.	• Why is splicing of wires to be avoided when possible, especially around engines? • Why are splices not permitted in most fire detector circuits around engine areas? • Where are splices permitted around engines and how must they be protected against vibration?
Preparation of wires.	• When stripping cable for splicing, how many wires may be cut or knicked? • When insulation of a cable has been damaged, how far back should the cable be stripped? • What types of insulation are permitted around engines?
Types of splices.	• What is the difference between a preinsulated and non-insulated splice connector? • What type of tool is necessary to make an acceptable splice, with a crimped splice connector? • What must be provided for insulation of non-insulated spliced connectors when used in powerplant areas? • Why are solder splices considered as temporary and not recommended, especially around engines?
Bonding jumpers.	• What kinds of metal are used for bonding jumper straps?

	•Where are copper straps required? •What type of bonding straps are usually used around turbine engines? •How clean must attachment surfaces be for bonding jumpers?
Allowable resistance.	•What is the maximum resistance allowed for any bonding jumper connection? •Where is the resistance measured?
Bonding connection.	•How is the contact area to be prepared? •How are engines bonded to their mounting structure to assure a good ground? •Where are the instructions found for methods of bonding attachment at firewalls or cowling?
Identification of aircraft electric cables.	•What types of insulation are permissible in areas around aircraft engines? •Why is stranded cable usually used in engine electrical systems wiring? •What type of shielding is used and why? •How can aluminum wire be identified without inspecting a cross section? •How can the wire size be determined? •What is unique about thermocouple wiring?
Installation of wiring in conduit.	•What is the purpose of conduit for electric wiring around an aircraft powerplant?
a. Removal of damaged wiring from conduit.	•After disconnecting wiring, how should the cables be pulled out of the conduit? •What provision should be made for a pull wire or "snake" to pull the replacement wiring through the conduit?
b. Cleaning of conduit.	•Why may the conduit need to be cleaned after the old wiring has been removed? •Why is this more critical in engine areas? •How can the inside of the conduit be cleaned?
c. Preparation of wires for pulling through conduit.	•How many wires or cables should be pulled through at a time? •How are the wires prepared to aid in easing of pulling through? •When should terminals be installed on the wiring?
d. Check for correct circuit continuity.	•What equipment may be used to check the circuit continuity? •How can voltage drop measured across the ground return path be used for determining integrity of grounds?

Activities	*Check Items*
	Did the student:
Select and install five solder type terminal lugs on various sizes of copper aircraft wire or cable.	•Properly strip and prepare wire or cable? •Use suitable solder iron? •Tin the wire and inside of cup before inserting wire?
Select and install eight crimp type terminal lugs on copper wire and cable and at least two crimp lugs on aluminum cable.	•Select correct crimping tool for each type of crimp lug? •Strip proper length of insulation? •Check for wire being visible in inspection hole? •Use aluminum lugs for aluminum cable? •Use anti-corrosion compound in each aluminum lug?
Make five splices with crimp type connectors, two of which are non-insulated.	•Use proper crimping tool? •Install adequate insulated sleeving on wire before installing connector? •Tie sleeving at each end after sliding over connector?
Select and install five bonding jumpers to bond selected aircraft engine electrical components which require bonding.	•Make proper choice of copper or aluminum bonding jumper for each component? •Use more than one jumper where needed to carry required current?
Prepare a list showing identification data for ten different samples of aircraft electric cables used around reciprocating and turbine engines.	•Check for type of insulation, kind and size of wire for each sample? •Identify shielding on samples of shielded wire?
Remove damaged wiring from a conduit which has at least two bends. Prepare replacement wiring for installation.	•Disconnect all wires before pulling from conduit? •Pull through a "snake" wire or rope attached to one of the wires being removed? •Tie "snake" securely to all wires to be pulled through?

	Powder or wax wires for ease of pulling through? Cut all wiring with sufficient length to allow for installing terminals and making neat connections at terminal strips?
Use "snake" to pull wiring through the conduit.	Pull all wires through conduit together?
Install terminals on wires and connect to terminal strips in junction boxes, one of which is of a type to be mounted on an engine support member or brace.	Use proper terminal lugs and tools for making terminals? Route all wires for a neat installation? Connect all wiring in accordance with circuit diagrams?
Make continuity check of each circuit for being correctly connected.	Use suitable test equipment for making continuity checks? Use voltage drop method for checking integrity of bonding jumpers?

USE OF QUICK DISCONNECT ELECTRICAL CONNECTORS AND CHARACTERISTICS OF HIGH- AND LOW-TENSION ELECTRICAL WIRING.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- Given:
  Written information, AC 43.13–1 or equivalent publication, questions with multiple choice answers concerning the use of quick-disconnect plugs and receptacles, samples of aircraft connector plugs and mating receptacles, samples of high-tension and low-tension wire for electrical wiring associated with aircraft engines.

- Performance:
  The student will select answers for 14 questions dealing with the use of aircraft electrical quick-disconnect plugs and receptacles used in powerplant areas, methods of sealing against fluids and vapors, checking and care of pins and sockets, tightening and securing or safetying quick-disconnect connectors, and purposes of various types of inserts, seals, sleeves and grommets used in plugs and receptacles. He will write labels showing type and probable uses for 8 samples of high-and low-tension aircraft engine electric wiring cable including thermocouple wire.

- Standard:
  Select correct answers for ten questions. Write correct information labels for at least 3 samples each of high- and low-tension wire.

Key Points	*Feedback*
Quick-disconnect connector terminology.	What determines which is the plug and which is the receptacle?
a. Plugs and receptacles.	What determines whether a plug or receptacle is male or female?
b. Male and female.	Explain the difference between plugs and receptacles, and pins and sockets in connectors.
c. Pins and sockets.	What is the difference between threaded and twist-lock connectors?
Classes of connectors as given in AC 43.13–1.	Name some aircraft powerplant uses of quick-disconnect connectors and class of connector required for each. Explain purposes for having rubber or neoprene inserts around the pins and sockets. Explain the meaning of "vapor proof" connectors. How do connectors for thermocouple wiring differ from other connectors?
Wire connection. a. Solder. b. Crimped.	Compare the advantages and disadvantages of soldered and crimped wire connections and connectors in engine and nacelle areas.
Pin and socket locator identification letters or numbers.	What special tools are required for crimped-type connectors? By what methods are pin and socket locator letters or numbers provided on plugs and receptacles? When locators are unreadable, how can wire numbers be used to locate desired pins or sockets?
Causes for malfunctions:	What is the hazard of too frequent disassembly of connectors for inspection?
a. Wires frayed or broken.	What malfunctions are probable from engine vibration causes?
b. Pins bent, broken off, or loose.	What fault is usually indicated by an arced or burnt pin? What precautions must be taken when straightening bent pins?
c. Sockets enlarged or corroded.	What causes a socket to become enlarged?

	• Why is corrosion more likely in connectors that go through the fire wall? • If corrosion is present, on a pin, what should be done about its mating socket?
d. Worn or corroded pins.	• What is the proper repair procedure for a pin worn beyond limits? • How should corroded pins be cared for?
Wire protection.	• What causes frayed or broken wires at the shell inlet? • What causes swollen or softened insulation in engine areas? • What should be provided to protect the wires at the inlet? At the pin or socket connection?
Methods of securing and safetying connectors.	• How should a threaded connector be tightened? How tight? • What should be provided to assure a threaded connector not vibrating loose? • Why is this more critical on engine electrical connectors? • How are twist lock or bayonet type connectors secured? • Why are twist lock or bayonet types seldom used in engine areas? • How should a safety wire be installed?
Ignition high-tension wiring.	• What are the two principal purposes of shielding? • What is corona and what does it indicate? • What type of ignition wire can be used to reduce radio interference without the use of shielding? • Why are turbine engine ignitor leads even more critical as to insulation and shielding than reciprocating engine spark plug leads?
Engine instrumentation wiring.	• Why is wiring for engine instruments usually either shielded or in conduit, especially for turbine engines? • What methods of securing are used for engine instrument wiring?
Low-tension wiring in engine areas. a. Insulation.	• Why is the insulation required for engine electrical low-tension wires more critical than in most areas of an aircraft? • Compare the insulation needs of 208 volt 3 phase cable with high-tension cable and 14/28 volt engine wiring.
b. Shielding.	• Why should all ignition wiring be well shielded-preferably double shielded? • What is the primary purpose of shielding for AC cable?
Low-tension ignition primary wiring.	• What is the reason that low-tension ignition primary wires need to be better insulated than other electrical system wires?
Thermocouple wiring.	• What special kinds of metal are used for thermocouple leads? • What level of voltage and current is carried by thermocouple wire? • What is the normal repair procedure for a broken thermocouple wire? • Why must thermocouple wires be kept at their original length when repaired or replaced?

INSTALL AND WIRE SOLENOID OPERATED SWITCHES, DETERMINE CAUSES AND EFFECTS OF SOLENOID SWITCH CHATTER.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
  Written information concerning aircraft solenoid switches, an aircraft or mock-up with power source, and an aircraft component to be controlled by a solenoid switch, samples of solenoid switches and relays which have been subjected to switch chatter in varying degrees of severity.

- **Performance:**

The student will install a solenoid operated switch and connect it from a power source to an engine electrical component with appropriate control circuit and circuit protection devices. He will inspect five solenoid switches and relays which have been damaged to varying degrees by switch chatter arcing, list the probable causes, extent of damage and repairability for each sample.

- **Standard:**

The solenoid switch will be installed in accordance with specifications provided and the component it controls will operate correctly when the solenoid switch is energized. Cause, extent of damage, and repairability will be correctly listed for at least four solenoid switches inspected.

Key Points	*Feedback*
Solenoid operated switches.	• What is the need for a solenoid operated switch? • What engine components are usually controlled by solenoid operated switches? • Where is the solenoid switch usually located in relation to the component it controls? • How can the current ratings for the switch contacts and the operating coil be determined? • How can the wire size requirements be determined?
Solenoid switch chatter causes.	• Name three causes for solenoid switch chatter. • Why will low voltage or an over tensioned spring cause similar chatter?
Symptoms and effects of solenoid chatter.	• What are some symptoms of solenoid chatter in an airplane starter circuit? • What type of damage to the contact surfaces usually results from chatter? • What can cause the contacts to fail to open after excessive contact chatter?
Preventative or corrective action.	• Why is a capacitor often recommended to reduce arcing or pitting of contacts? • Where can information be found for proper adjustment of solenoid spring tension? • How can contacts be cleaned or dressed to make temporary repairs?
Checking operation of a solenoid operated switch.	• What is the primary check for the operation of a solenoid switch circuit? • At what steps of the operation should the contact points be checked for proper operation and condition? • How can voltage drop across the contacts be used as a check of operation?

Activities	*Check Items*
	Did the student:
Install a solenoid operated switch on an aircraft or mock-up. Connect it to an engine electrical component, to a power source, and to a control switch with appropriate circuit protection devices. Check for proper operation of the component and the solenoid switch.	• Determine current requirements and select wire of proper size from wire tables in AC 43.13–1? • Use acceptable connecting techniques for the wiring? • Select fuses or circuit breakers of correct rating for the wire used? • Check operation of the component under normal load? • Check contacts for proper closing and opening of contacts and absence of excessive arcing?
Inspect samples of solenoid switches and relays with damage from contact chatter. List the extent of damage, probable cause of chatter, and repairability of each sample.	• Check type of damage? • Check for incorrect spring tension? • Check extent of pitting of contacts? • Check for improper alignment or seating contacts? • Check for integrity of contact wiring and connections?

21. REPAIR ENGINE ELECTRICAL SYSTEM COMPONENTS. (EIT = 19.5 hrs., T = 11.0 hrs., L/S = 8.5 hrs.) 4 segments

(UNIT LEVEL 2)

USE SERVICE MANUALS AND PARTS CATALOGS TO LOCATE PROCEDURES FOR REPAIR OR REPLACEMENT OF ENGINE ELECTRICAL SYSTEM COMPONENTS AND TO OBTAIN PART NUMBERS FOR REPLACEMENT PARTS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
  A manufacturer's service manual and parts catalog for a specific aircraft, and a list of two faults in engine electrical systems and three defective engine electrical components applicable to the specified aircraft.

- **Performance:**
  The student will use the service manual provided to locate procedures for repair of the faults listed and replacement of the defective parts, listing all reference pages. He will use the parts catalog provided to list the part number and nomenclature for parts needed for the engine electrical components to be replaced.

- **Standard:**
  At least 80 percent of the reference pages will be correctly listed and 70 percent of the parts needed will be correctly listed as to part number and nomenclature.

Key Points	*Feedback*
Using service manuals.	• What is meant by repair of a system? • Why is some descriptive information usually provided in service manuals for each electrical system and its components? • How can trouble shooting charts be used to assist in repairing an engine electrical system? • What is the importance of understanding the organization of material and method of indexing for a manufacturer's service manual?
Procedures for component repair or adjustment.	• When an electrical component may be repaired, how is this indicated in the manual? • If the manual only provides replacement and/or adjustment procedure, what assumption is to be made concerning possibility of repairing the component, except in a specialized shop? • When procedures are given for replacement of an electrical component, why is removal always covered first and installation only covered when it differs from the reverse of removal? • If detailed step-by-step procedures are given, how important is it that they be followed explicitly?
Locating information for repair or replacement of engine electrical components not shown in Engine Accessories chapters.	• Why are procedures for repair or replacement of engine electrical components often found in the electrical section of a manual? • Where will all electrical circuit diagrams for engine electrical components be found? • Why are certain engine electrical components covered in the Air Conditioning section of some manuals?
Use of parts catalogs.	• What are the methods of indexing a parts catalog? • How can the parts nomenclature be found if only the part number is known? • What is the purpose of parts breakdown illustrations and listings? How are they used? • How does a parts catalog usually show what additional hardware, seals, etc., may be needed for a component replacement?

Activities	*Check Items*
	Did the student:
Use the service manual and parts catalog for a specific aircraft to locate and list page references for repair information and procedures for two faulty engine electrical systems and to locate replacement procedures, parts numbers, and nomenclature for three defective engine electrical components.	• Properly use the service manual index to find page numbers needed? • Include trouble shooting information in repair references for system repairs? • Use the parts catalog alphanumeric index properly? • List all associated hardware, seals, etc., that may be needed for each component replacement?

CHECK, TROUBLESHOOT AND REPAIR AN AIRCRAFT DUAL DC GENERATOR ELECTRICAL SYSTEM.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  Written information, manufacturer's instruction manual, an aircraft or mock-up with an operative DC dual generator system, appropriate tools and test equipment.

- Performance:
  The student will read and record voltage and output current for each generator at various RPM, adjust the voltage regulators, adjust load equalization, flash a generator field, check the operation of the reverse current cutout relays, locate and correct at least three open or short circuit malfunctions introduced by the instructor.

- Standard:
  All procedures will be performed in accordance with the information and specifications provided.

Key Points	*Feedback*
Compound DC generator electrical system components.	•Compare single and multiple generator systems as to components required. •How many wires are normally connected to a compound DC generator?
Voltage regulators.	•Why are all line adjustments usually confined to voltage regulation? •Why is it preferable to use a test voltmeter when adjusting a voltage regulator instead of the airplane voltmeter (if provided)? •Why should a generator system be operated for a specified time before adjustment is made?
Equalizing circuit and adjustment.	•In multiple generator systems, why must all generators be operating and connected to the combined electrical load before equalizing adjustments are made? •Why should each voltage regulator be checked for being set to the same voltage before equalizing adjustments are made?
Effect of residual or stray magnetism in a generator field.	•What will be the effect on generator operation of a field magnetized in reverse polarity?
Flashing the field.	•What is accomplished by flashing the field of a generator? •When is it necessary to flash the field? •How is a battery connected to flash the field from the regulator? •What is provided in some regulators to keep the field polarized properly and reduce the need for flashing?
Reverse current cutout relays.	•What is the purpose of the reverse current cutout relay? •When does it operate? •What are the probable results if points fail to open? Fail to close?
Voltage and current indication.	•When a voltmeter is provided, what specific voltage is it indicating? •When an ammeter is provided, what specific current is being measured? •If an indicator light is substituted for meters, how is a voltage reading obtained for voltage regulator adjustment?
Effects of open and short circuits.	•What will be the effect on output current of an open circuit to the generator field? A short circuit?
a. Generator field circuit.	•Why is the field circuit normally protected by a circuit breaker?
b. Reverse current relay circuit.	•What happens to a generator when reverse current flows into it?
c. Equalizing circuits.	•On a system with load or current meters, what will be the indications of a shorted and open equalizing circuit?

Activities	*Check Items* Did the student:
In an operating dual DC aircraft generator control system:	•Provide adequate warmup time? •Use test voltmeter?

a. Check voltage of each generator output.	•Check system voltmeter against test voltmeter (if system voltmeter is provided)? •Use adequate RPM? •Read meters accurately?
b. Check output current of each generator while operating in parallel.	•Use test ammeter? •Check system load meter or ammeter against test ammeter (when system meter is provided)?
c. Check output of each generator separately.	•Reduce load, if necessary to not exceed rating of one generator? •Cut off the generator not being tested?
d. Adjust voltage regulators and use a battery to flash the field from the regulator.	•Use test voltmeter? •Follow procedure provided? •Make sure both generators are operating at same voltage?
e. Adjust equalization.	•Adjust for equal load on each generator while operating at same RPM?
Use test equipment and troubleshooting procedures to locate three different open or short circuit malfunctions introduced by the instructor.	•Use diagrams and instruction manual to assist in locating troubles? •Use continuity check to aid in locating malfunctions?

DETERMINATION OF APPROXIMATE ACTUAL AND MAXIMUM PERMISSIBLE CONTINUOUS LOAD ON AN AIRCRAFT ELECTRICAL GENERATING SYSTEM.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  A written description of the electric system of a specific aircraft, a chart or list giving the electric current requirements for each electrical component of that aircraft which was designed for continuous operation, and manufacturer's specifications for the generating system or equivalent pertinent information.

- Performance:
  The student will calculate the approximate total continuous load on the aircraft electrical system with all components operating which were designed for continuous operation. He will determine the maximum permissible continuous electrical load which may be imposed on the aircraft generating system.

- Standard:
  The total load and the maximum permissible load will be determined with less than 20 percent error.

Key Points	*Feedback*
Calculating total continuous electrical load.	•When starting and running currents are both specified, which should be used for calculating continuous load? •When a motor is rated in horsepower, how is the approximate electrical load calculated? •What types of motors or electrical loads should not be included in total continuous load?
Determining maximum permissible load on an electrical system.	•If an aircraft has two 60 ampere generators with 80 percent continuous load rating, what is the maximum permissible continuous load in amperes? •How can the total continuous load be calculated? •How can an ammeter be connected in the generator output circuit to check the actual load with all continuous operation units on?

Activities	*Check Items* Did the student:
Calculate the approximate continuous total electrical load imposed on an aircraft generating system, when the individual current requirements of each continuous operation electrical component is given. Determine the maximum permissible load which may be imposed on the generating system of the aircraft.	•List all types of electrical components which may operate continuously? •Determine current requirements for all such components? •Add all requirements to arrive at a total load? •Use manufacturer's service manual or equivalent information to determine percent of rated output which the total continuous load should not exceed?

INSPECT, CHECK, AND REPAIR SOLENOID OPERATED VALVES FOR ENGINE PNEUMATIC FUNCTIONS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- Given:
  Written information or manufacturer's service manuals, a solenoid operated turbine engine starter valve, a solenoid operated pneumatic control valve, and a solenoid type hold-in switch, a mock-up with power source for operating and checking the solenoid valves and switch, suitable test equipment, tools and parts.

- Performance:
  The student will inspect, check, and repair as needed three solenoid operated or controlled engine accessory components, at least two of which are inoperative due to faulty solenoid operation. He will determine cause of failure, obtain repair parts needed and accomplish repairs, then make any adjustments specified in the manuals provided.

- Standard:
  At least two of the three components will be properly checked and cause of trouble determined correctly. Procedures will be correctly followed in accordance with information provided.

Key Points	*Feedback*
Purposes of solenoids as used in pneumatic valves.	•What action is performed by the solenoid? •Explain how a solenoid can function either to pull in or push out an actuator shaft. •How is a spring used to return the shaft to the de-energized position in each type of solenoid action? •What is the effect of the solenoid action on the pneumatic function it is controlling?
Effects of power failure on a solenoid valve or switch.	•Why does the solenoid actuator shaft return to its de-energized position when power is off? •Why are most solenoids operated by 12 or 24 volt DC?
Checking operation of solenoid valves.	•How can a solenoid operate on AC? •How can a continuity check be made for the solenoid coil? •How are some solenoids provided with a manual override?
Turbine engine starter switcher valves.	•What action is performed by the solenoid in the starter valve? •How is a manual override usually provided for starter valve solenoids? •How can the position of the starter valve butterfly be determined visually?
Solenoid hold-in switches.	•How can a hold-in coil be used to hold a push-in or pull-out switch? •What returns the switch to its normal position when the holding coil is de-energized? •How can the operation of a holding coil be checked without operating the component it controls?

Activities	*Check Items* Did the student:
Using a mock-up with power source, inspect, check and repair as needed three solenoid operated or controlled engine accessory components: a turbine engine starter valve, a pneumatic valve controlled by a solenoid, and a solenoid hold-in type switch. Procedures for repair or replacement of faulty solenoids or related parts will be obtained from information provided and will be followed in accomplishing repairs and making any adjustments needed.	•Check the proper operation of each valve? •Check pneumatic operation with the solenoid override used where such is provided? •Check operation of the solenoid hold-in switch with and without electrical power connected to the hold-in coil? •Check continuity of each solenoid coil properly?

22. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE TEMPERATURE, PRESSURE, AND RPM INDICATING SYSTEMS.

(EIT = 18 hrs., T = 11 hrs., L/S = 7 hrs.)

6 segments

(UNIT LEVEL 3)

OPERATING PRINCIPLES AND INSTALLATION PRACTICES OF TEMPERATURE INDICATING SYSTEMS FOR AIRCRAFT ENGINE INSTRUMENTATION.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Written information, samples of thermocouple, resistance/ratiometer, and vapor pressure types of temperature indicating systems, questions with multiple choice answers.
- Performance:
  The student will select answers to 15 questions concerning the identification of each type of temperature indicating system, the operating principles of each type, applications for which each type is most suitable, and installation practices for each type.
- Standard:
  Select at least 11 correct answers.

Key Points	*Feedback*
Engine related applications of temperature indicating systems.	•How much information about engine operation can be derived from temperature indication? •Describe the relative temperature ranges associated with each of the following: a. Cylinder head temperature. b. Carburetor intake air. c. Oil temperature. d. Exhaust gas temperature.
Operating principles of temperature indicating systems.	•What are the basic principles of operation for each of the following types of temperature indicating systems: a. Thermocouple? b. Resistance/ratiometer? c. Vapor pressure? •Why are thermocouple type indicators best suited for high temperature applications such as cylinder head and exhaust gas temperature indicators?
Installation practices. a. Thermocouple type.	•Describe the special wiring requirements for a thermocouple temperature indicating system? •What effect would the use of copper wire have? •Why is splicing or grounding of either thermocouple wire prohibited?
b. Resistance/ratiometer type.	•Why are two wires used instead of using the airplane body for return? •At what point is the negative wire grounded to the airplane body? •What is the source of power for a resistance type system?
c. Vapor pressure type.	•Why is a vapor pressure type system seldom used in multi-engine aircraft? •What precautions must be observed with respect to the Borden tube and transmission tube? •Where and how would a vapor pressure temperature bulb be installed in an oil temperature system?

CHECK, TROUBLESHOOT AND REPAIR THERMOCOUPLE AND RESISTANCE/RATIOMETER TEMPERATURE INDICATING SYSTEMS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's troubleshooting manuals or equivalent written information, an operative engine or a mock-up having thermocouple and resistance/ratiometer types of temperature indicating systems installed and operative, instrument test equipment and/or a voltohmmeter.

- **Performance:**
  The student will measure the resistance of the thermocouple leads, determine the causes of erratic indications and inverse reading in a thermocouple temperature indicating system and an off-scale reading in a ratiometer temperature indicator, and apply markings to the glass face of engine instruments to show operating limits.

- **Standard:**
  All work will be performed in accordance with the procedures provided. Malfunction causes will be in agreement with troubleshooting information provided.

Key Points	*Feedback*
Thermocouple temperature indicating system troubleshooting.	• What is the source of power in the indicating circuit? • Should the circuit have relatively low or high resistance? • Why is an erratic resistance reading a cause for concern?
Causes of incorrect indications.	• What is the most likely cause for an erratic reading? • What is the cause for an inverse reading in the indicator? • What type of reading will result from shorted leads into the temperature probe? • What effect will a short of the leads at the indicator have?
Resistance/ratiometer temperature indicating system troubleshooting.	• What is the source of power for a resistance/ratiometer type indicating system? • How is a ratiometer indicator adjusted for low and high scale limits? • What will be the effects of a short or an open at the temperature probe? • What will be the effects of a short or open at the indicator? • What would be the effect of an open circuit at the ground connection?
Application of markings to glass faces of engine instruments.	• What is the purpose for the application of marks on the glass face? • What is the significance of red, yellow and green colored marks? • How is the correct size and position for each mark determined? • What is the reason for a slippage mark and how is it installed?

Activities	*Check Items* Did the student:
On an operating engine or mock-up with thermocouple and resistance/ratiometer temperature indicating systems, determining causes for erratic thermocouple indicator readings, inverse reading at the indicator and measure the circuit resistance of the leads to the thermocouple. Determine cause for off scale readings in the resistance/ratiometer indicator and apply markings to the glass face of the indicators in accordance with the specifications provided.	• Perform correct pre-starting and starting steps, if an engine was used? • Correctly set up power for the mock-up, if used? • Determine causes for malfunctions specified, by creating poor and reversed connections in the wiring for the temperature indicating systems? • Check resistance of thermocouple leads with and without the probe and indicator being connected? • Use engine operating specifications to determine location of markings on indicators? • Properly secure engine or mock-up at conclusion of operation?

PURPOSE, OPERATING PRINCIPLES, AND TROUBLESHOOTING OF MANIFOLD PRESSURE INDICATING SYSTEMS.

(SEGMENT C, LEVEL 1)

Student Performance Goal

- **Given:**
  Written information, diagrams or cutaway drawings of a manifold pressure indicating system, and completion type essay statements.

- **Performance:**
  The student will complete 10 essay statements concerning the purpose and operating principles of manifold pressure indicating systems, the effects of leaking or broken pressure gauge lines and the effects of a plugged or iced-over static pick up source.

- **Standard:**
  Correctly complete at least 7 essay statements.

Key Points	*Feedback*
Manifold pressure.	• What is meant by manifold pressure? • Where is manifold pressure indication normally taken? • What unit of measurement is used for manifold pressure?
Operating principles of a manifold pressure indicating system.	• What are the major components of a manifold pressure indicating system? • What two pressures are compared by the gauge? • Where is the static air pressure obtained in unpressurized and pressurized aircraft? • What will the manifold pressure gauge read when the engine is not running?
Effects of malfunctions.	• How will a leaking pressure line effect gauge indication? • What will be the effect of a broken pressure line? • What will be the effect on the gauge of a clogged or iced-over static pressure line?

INSPECT, CHECK, TROUBLESHOOT AND REPAIR ENGINE TACHOMETER SYSTEMS.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's manual or equivalent written information, an engine or mock-up with provision for installation of a tachometer drive, a flexible shaft tachometer system, an electric tachometer system, and a voltohmmeter.

- Performance:
  The student will install and check operation of a flexible drive tachometer system, and an electric tachometer system. After a malfunction has been introduced by the instructor into the electrical tachometer system, resulting in failure of operation, he will determine the cause of the failure by inspection and use of a voltohmmeter and repair the system.

- Standard:
  Installation and operational checks will be performed in accordance with procedures provided. Determination of cause of failure will be correct and repair will be accomplished at return-to-service standards.

Key Points	*Feedback*
Types of tachometer indicating systems.	• Name two basic types of tachometer systems. • To what types of aircraft are flexible drive tachometers most suitable? • Why is an electric AC generator system more accurate than cable drive? • What is the difference between a reciprocating engine tachometer system and a jet tachometer system? • Does the tachometer indicating system use an external source of power? Why?
Troubleshooting tachometer systems.	• What are some causes of a cable drive tachometer failure? • List several reasons for failure of an electric tachometer system. • What will be the result of opening of any wire in the connecting circuit?

Activities	*Check Items* Did the student:
Install and check operation of a flexible drive tachometer.	• Make sure flexible drive was properly meshed at each end?
Install and check operation of an AC generator tachometer system.	• Check for free operation of drive shaft and indicator? • Make sure transmitter and indicator were both well grounded?
Determine reason for a failure in operation, resulting from an instructor introduced malfunction.	• Use visual inspection and voltohmmeter for checking to determine reasons for the failure?
Repair the system to return-to-service standard.	• Follow procedures provided in making repairs? • Check operation after repairs were completed?

PURPOSES, OPERATING PRINCIPLES, REQUIREMENTS AND APPLICATIONS OF ENGINE INLET AND OUTLET TEMPERATURE INDICATING SYSTEMS.

(SEGMENT E, LEVEL 1)

Student Performance Goal

- Given:
  Written information, questions with multiple choice answers concerning reciprocating and turbine engine temperature indication.

- Performance:
  The student will select answers for 10 questions dealing with the requirements for a carburetor air temperature indicating system, the types and applications of thermocouples used to indicate turbine engine temperatures, including how turbine inlet temperature ($T_t 2$) is obtained and used, and how discharge temperature ($T_t 7$) is sensed.

- Standard:
  Select at least 7 correct answers.

Key Points	*Feedback*
Carburetor air temperature indicating system requirements.	• What temperature range must the system be able to cover? • Why is a resistance/ratiometer-type indicating system better suited than a thermocouple type for this application?
Functions of system components.	• What is the function of the temperature bulb? • How does the ratiometer indicator function? • What is critical about the grounding point for this type of circuit? • What is the power source?
Troubleshooting.	• What malfunction will cause an off-scale hot reading? An off-scale cold reading? • What type of reading will result from a poor ground connection?
Operating principles.	• What are the primary components of an exhaust analyzer system? • What determines where the probe or probes are installed? • How are the indicators calibrated?
Turbine inlet temperature sensing.	• Name two requirements for compressor inlet temperature information. • What is meant by compressor inlet total temperature? • Where is this sensed? • Why does the fuel control need inlet temperature sensing? • Where is this information picked up?
Turbine engine thermocouple temperature indication applications.	• What type of probes are used for turbine discharge temperature sensing? • Why must they be built to withstand extremely high temperatures? • Why is more than one probe generally used for discharge temperature ($T_t 7$) pickup? • What is meant by turbine discharge total temperature?

PURPOSES, OPERATING PRINCIPLES AND APPLICATIONS OF PRESSURE INDICATING AND WARNING SYSTEMS USED WITH AIRCRAFT ENGINES.

(SEGMENT F, LEVEL 1)

Student Performance Goal

- Given:
  Manufacturer's manuals or equivalent written information, schematic diagrams, and questions with multiple choice answers dealing with oil and fuel pressure indication and warning systems.

- Performance:
  The student will select answers to 12 multiple choice questions concerning types and operating principles of oil pressure indicating and warning systems, fuel pressure indicating and warning systems as used with reciprocating and turbine engines, and the sensing of turbine engine pressure ratio (EPR) indication.

- Standard:
  Select correct answers for at least 8 questions.

Key Points	*Feedback*
Oil pressure indicating systems.	• What is the basic principle of operation of synchro-type oil pressure indicating systems?

	•What is the importance of oil pressure indication for turbine engines? •Why are direct reading oil pressure indicating systems limited to light aircraft generally?
Oil Pressure Warning systems.	•Why do many turbine engines have both low oil pressure warning and oil differential pressure warning? •How is low oil pressure warning provided with direct reading oil pressure indicating systems?
Fuel Pressure indication and warning systems.	•At what points in engine fuel feed systems may fuel pressure be measured? •If fuel pressure warning is provided, what is its purpose and operating principle? •In a turbine engine, how is warning provided if fuel pressure drops at the fuel filter outlet?
Turbine engine pressure ratio (EPR) indication.	•What two pressures are compared to obtain EPR? •What is meant by the symbols P_t2 and P_t7? •What type of indicating system is used to sense or pick off these pressure indications? •What is the operating principle of the EPR gauge?

23. TROUBLESHOOT, SERVICE AND REPAIR FLUID RATE OF FLOW INDICATING SYSTEMS.

(EIT = 2.5 hrs., T = 2.0 hrs., L/S = 0.5 hrs.)

1 segment

(UNIT LEVEL 2)

TROUBLESHOOT AND SERVICE.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Written information, diagrams and charts and questions requiring essay type answers or mathematical computations.

- **Performance:**
  The student will draw a diagram of a mechanical fuel flow indication system for a reciprocating engine and of an electrical fuel flow indication system for a turbine engine and with reference to these diagrams, where applicable, he will write answers to 7 questions regarding the difference between fuel flow indicating systems, the purpose and operating principles of reciprocating and turbine fuel flow indication systems, and the direct relationship between fuel flow and engine power output.

- Standard:
  Two diagrams drawn by the student will each show at least 75 percent of the details shown in the diagrams provided and will agree in flow pattern and circuit information. At least 5 questions will be answered in accordance with the information provided.

Key Points	***Feedback***
Types of fuel flow indicating systems.	•What is a primary difference between fuel flow indicating systems of the mechanical and the electrical type? •What is the major difference between electrical fuel flow meters for reciprocating and turbine engines?
Purpose of fuel flow indicating systems.	•What information is derived from a fuel flow meter? •How is fuel flow used in setting up engine operation? •Compare the accuracy of the indication of a mechanical fuel flow meter with an electrical type.
Components and operation of a fuel flow indicating system.	•What are the primary components of a fuel flow indicating system? •How are fuel flow indicators calibrated? •From where is the flow indication taken?
Relationship between fuel flow and power output of an engine.	•How does an excessive fuel flow effect power output? •How does a deficient fuel flow effect engine power output? •How accurate is fuel flow as an indication of engine power? •Why are fuel flow indicators not required for all aircraft?

Troubleshooting and servicing fuel flow indicating systems.	• If engine operation was normal, but fuel flow was reported very high, which components should be checked? • Why is adjustment of a fuel flow meter or indicator not practical in line service?

Activities	*Check Items* Did the student:
Draw a diagram of a mechanical fuel flow indication system for a reciprocating engine and an electrical fuel flow indication system for a turbine engine.	• Show all components of each system in his diagrams? • Label all components? • Show proper relative rate of flow per unit of time for each system?

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ENGINE FIRE PROTECTION SYSTEMS

24. INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE FIRE DETECTION AND EXTINGUISHING SYSTEMS. (EIT = 5 hrs., T = 2.5 hrs., L/S = 2.5 hrs.) 2 segments

(UNIT LEVEL 3)

INSPECT, CHECK, TROUBLESHOOT AND REPAIR ENGINE FIRE DETECTION SYSTEMS.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's manuals or equivalent written information, an aircraft or mock-up with an engine fire detection system installed, test equipment, tools and parts suitable for checking and repairing the fire detection system.

- Performance:
  The student will test the operation of an engine fire detection system, check continuity of the circuit, check individual fire detectors, locate and correct a malfunction introduced by the instructor.

- Standard:
  Test of system, check of continuity and of individual detectors will be accomplished in accordance with procedures provided. Correction of malfunction will be accomplished to return-to-service standards.

Key Points	*Feedback*
Engine fire detection systems.	•In what areas around an engine is fire detection provided? •Which types of fire detectors are best suited for reciprocating engines? For turbine engines? •How are false fire warnings due to radiated engine heat prevented?
Checking individual fire detectors.	•How can thermal-switch types of fire detectors be checked? •How can thermocouple types be checked? •How can continuous loop types be checked?
Checking fire detection systems.	•Why is a test method usually provided to check an engine fire detection system for being operative? •What type of test equipment may be used to locate system malfunctions for each type of fire detection system?

Activities	*Check Items* Did the student:
Test the operation of a fire detection system on an aircraft or mock-up by built-in test provision and by heating of a fire detector in the system.	•Hold the test switch for a sufficient time to assure an adequate test? •Use a safe method of providing heat at a fire detector?
Check continuity of a fire detection circuit.	•Use a voltohmmeter or fire detection test unit to check all detectors and the circuit? •Consider the type of detectors in use to determine how continuity of the circuit may be checked?
Locate and correct a malfunction of the fire detector system introduced by the instructor.	•Follow good troubleshooting practices in checking logical sections of the circuit to isolate the trouble? •Replace the defective unit or repair wiring faults to a return-to-service standard?

INSPECT, CHECK, SERVICE, TROUBLESHOOT AND REPAIR ENGINE FIRE EXTINGUISHING SYSTEMS.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  Manufacturer's manual or equivalent written information, an engine fire extinguishing system on an aircraft or mock-up, test equipment and tools suitable for checking and repairing the fire extinguishing system.

- Performance:
  The student will inspect all components of the fire extinguishing system, check for correct operation of the system with the container removed, check for proper arming and firewall shut-down, check pressure of the container, install a charged container and secure it in ready contition, inspect indicator discs for being properly seated, and list three possible causes for failure of an engine fire extinguishing system to operate.

- Standard:

  Inspection, checking and container installation will be accomplished in accordance with procedures provided. Three possible causes of system malfunction will be correctly listed.

Key Points	*Feedback*
Engine fire extinguishing systems.	• What areas around a reciprocating engine can be reached by the fire extinguishing agent? • What systems are shutdown when the fire extinguishing system for an engine is armed? Why? • What areas around a turbine powerplant can be reached by fire extinguishing agent?
Methods of operating engine fire extinguishing discharge units.	• Explain how a cable operated engine fire extinguishing discharge unit differs from an electrically operated unit. • What must be done on a cable operated unit to prepare it for container replacement? • How is an electrical control head made safe for container replacement?
Checking operation of engine fire extinguisher systems.	• What methods are provided to permit checking operation without actually discharging the container? • How often should the system be tested for full operation including actual discharge? • What are the procedures for actuation of an engine fire extinguishing system for an actual fire emergency?
Normal and thermal discharge indicator discs.	• What type of indicators are provided to show when a bottle is discharged normally and when it has been discharged due to excessive heat expansion? • How are these discs reset when a discharged bottle is replaced?
Causes for system failure to operate.	• Which components of the system are most likely to be the cause of a failure to obtain discharge when actuated?

Activities	*Check Items* Did the student:
On an aircraft or mock-up with an engine fire extinguishing system, inspect components and check container pressure, remove the charged container, check arming operation and firewall shutdown of fluid lines and air ducts, then check operation of discharge mechanism when actuated. Replace charged container, check for proper seating of discs, and security of discharge unit.	• Make sure container would not be accidentally discharged when removed, by properly disengaging discharge unit? • Pull fire extinguisher lever to armed position when checking for proper firewall shutdown? • Pull extinguisher lever to full extension or press discharge switch to check for discharge activation? • Make sure lever was returned to full off or in position before replacing charged container? • Install safeties where called for and make sure all procedure steps were completed?
List three possible causes for failure of the system for discharge when actuated.	• Select logical causes as suggested in troubleshooting procedures provided?

25. INSPECT, CHECK, SERVICE, AND REPAIR FIXED – PITCH, CONSTANT-SPEED, FEATHERING PROPELLERS, AND PROPELLER GOVERNING SYSTEMS. (EIT = 33 hrs., T = 14 hrs., L/S = 19 hrs.) 10 segments

(UNIT LEVEL 3)

IDENTIFY AND DESCRIBE THE FORCES ACTING ON A PROPELLER.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
  Completely assembled and disassembled sample propellers of the fixed pitch and variable pitch types; diagrams or drawings illustrating the forces acting on a propeller, and the manufacturer's service manual for one specific propeller.

- Performance:
  The student will point to and use the correct nomenclature to identify the hub, splines, blade face, blade back, blade tip, blade retaining device, counterweight and pitch control mechanism. Using the diagrams or drawings, he will describe and explain the forces acting on a propeller and the reasons for using variable pitch. He will interpret information from the service manual and describe the operation of a particular controllable pitch propeller.

- Standard:
  Correct nomenclature will be used throughout all descriptions and explanations. The explanation of forces acting on the propeller and the theory of variable pitch will be in accordance with the information in the manual.

Key Points	*Feedback*
Types of propellers.	• What is the meaning of the term "fixed" when it is applied to the description of a fixed-pitch wood or metal propeller? • What is a ground adjustable propeller? • What is a variable pitch propeller? • What additional component or control is necessary to permit a variable pitch propeller to operate as a constant speed propeller? • What is a reversible pitch propeller?
Propeller nomenclature.	• What are the two conventional methods of attaching the propeller hub to the propeller shaft of the engine? • How is the rotational force of the shaft transmitted to the hub on a splined shaft? On a tapered shaft? On a flanged shaft? • How are the propeller blades retained in the propeller hub on variable pitch propellers? • What features distinguish the face and back of a propeller blade? • What part of a propeller blade is usually identified as the "tip" of the propeller? • What is a propeller blade counterweight? • What methods are available for changing the pitch of the blades on various types of propellers?
Forces acting on propellers.	• What part of a propeller is subjected to the most severe centrifugal forces? • What is an aerodynamic twisting moment? • What is centrifugal twisting moment? • What forces act on the counterweight assembly of a propeller? • Where are bending loads applied to a propeller?
Pitch control systems.	• How can mechanical pitch change mechanisms be used to vary the pitch of a propeller? • If electric motors are used to power the pitch control mechanism, where may the electric motor be located? • If the pitch control is hydraulically actuated, what is the source of oil pressure?

Activities	*Check Items*
	Did the student:
Identify the parts of a propeller: a. Hub. b. Splines. c. Blade face and back. d. Blade retaining devices. e. Counterweights. f. Pitch change mechanism. Describe the forces acting on a propeller. Explain the operation of a controllable pitch propeller.	•Use correct nomenclature and correctly identify the parts of a propeller? •Use reference information, correctly interpret and describe the forces acting on a propeller? •Use reference information and correctly explain the operation of a controllable pitch propeller?

MEASURE PROPELLER BLADE PITCH ANGLES.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  A fixed pitch and a variable pitch type propeller; manufacturer's service information applicable to the two different propellers and the tools and equipment necessary to measure propeller blade angles.

- Performance:
  The student will check the propeller blade angles on a fixed and a variable pitch propeller and determine whether the propeller conforms to the tolerance specified by the manufacturer.

- Standard:
  The propellers need not meet return-to-service standards but the procedures for checking blade angles will be fully in accordance with the manufacturer's instructions. Blade angle measurement will permit a tolerance of ¼ degree.

Key Points	*Feedback*
Measurement of pitch angles.	•What circumstances would make the measurement of blade pitch angles necessary? •Where would a mechanic find information that would describe the procedure for checking pitch angle? •What tools and equipment are necessary to measure pitch angle if the propeller is not installed on an airplane? •If the mechanic elects to check blade pitch while the propeller is installed on the propeller shaft, what tools will be required?
Adjusting or changing blade pitch.	•What procedure is followed to change the pitch on a fixed pitch metal propeller? Who is authorized to make such a change? •How is the high and low pitch setting of a variable pitch propeller changed? Who is authorized to make this change?

Activities	*Check Items*
	Did the student:
Measure the blade pitch angles on a fixed pitch propeller. Measure the high and low pitch blade settings on a variable pitch propeller.	•Use and correctly interpret information from the service manual? •Correctly judge whether the propellers conformed to the manufacturer's specifications?

LOCATE AND INTERPRET ENGINE-PROPELLER "CRITICAL RANGE" INFORMATION.

(SEGMENT C, LEVEL 2)

Student Performance Goal

- Given:
  Copies of Aircraft Specification Sheets for five different airplanes, including copies of three aircraft-engine-propeller combinations which have "critical range" vibration problems; samples of placards which describe the "critical range" precautions or warnings and a copy of one Manufacturer's Operating Manual which describes a critical vibration range.

- Performance:
  The student will review the Aircraft Specification Sheets, selecting those three specifications identifying "critical range" vibrations for the airplane-engine-propeller combination. He will select the sample placard which should be installed on the instrument panel of the airplanes so identified, and explain the reason for the placard.

- **Standard:**
  Interpretation of information from the Specification Sheets and the manufacturer's manual will be without error or omission. The student will correctly identify those airplanes-engines-propellers which have critical range vibration problems.

Key Points	*Feedback*
Vibration.	• What causes vibration in an airplane, engine, propeller and helicopter rotor? • What is a resonant vibration?
Critical ranges.	• Why are "critical ranges" accepted on airplanes? • How may a mechanic identify those airplane-engine-propeller combinations that have critical range vibrations?
Placards.	• How are "critical range" vibrations discovered or detected? What information must appear on a "critical range" vibration placard? • How is a placard attached to the instrument panel?

Activities	*Check Items* Did the student:
Identify the aircraft specification sheets that contain information regarding "critical ranges."	• Correctly select the specification and identify the airplane-engine-propeller combination that resulted in "critical range" vibration?
Select the placard required for the airplane.	• Use correct nomenclature and terminology as a part of the explanation?

LOCATE AND INTERPRET "STATIC LIMIT" INFORMATION FOR FIXED PITCH PROPELLERS.

(SEGMENT D, LEVEL 2)

Student Performance Goal

- **Given:**
  Copies of Aircraft Specification Sheets for five different airplanes using fixed pitch propellers.
- **Performance:**
  The student will locate and interpret information that specifies the static RPM limits for each of the airplane-engine-propeller combinations.
- **Standard:**
  Information will be interpreted without error.

Key Points	*Feedback*
Static RPM limits.	• Why may the static limits be different if the engine is equipped with a different propeller? • Will the static limits apply if the airplane has been modified by the installation of a different type of engine? • If the engine and propellers are of the type specified in the Aircraft Specification Sheets but the engine-propeller combination will not meet the static limits specified, what may be the cause of the problem?

Activities	*Check Items* Did the student:
Locate and interpret the static limit for each of five different airplane-engine-propeller combinations.	• Use and correctly interpret the specifications? • Use correct nomenclature and terminology?

DESCRIBE THE OPERATION AND CONTROL BY A COUNTERWEIGHT PROPELLER.

(SEGMENT E, LEVEL 2)

Student Performance Goal

- **Given:**
  A counterweight propeller, cutaway or mock-up, and written information or a manual describing the operation of the propeller.
- **Performance:**
  The student will interpret reference information contained in the reference publications and describe the operation and control of a counterweight propeller.
- **Standard:**
  The information will be interpreted without error. Correct nomenclature will be used throughout the explanation and description of operation and control.

Key Points	*Feedback*
Types of counterweight propellers.	• What is implied if the propeller is described as a "two-position" counterweight propeller? • Why may a two-position propeller also be called a controllable pitch propeller? • If a counterweight propeller is described as a constant speed propeller, what other unit is required for operation in the constant speed range? • What is the difference in blade range for the Hamilton Standard two-position & constant speed propellers?
Operation and control of counterweight type propellers.	• What forces act on a propeller blade to increase the pitch of the propeller? What forces tend to decrease pitch? • When the pitch of the propeller blades is increased, how is engine RPM effected? • What unit boosts and controls the flow of oil to the pitch changing mechanism of a constant speed counterweight propeller? • Why are some counterweight propellers placed in high pitch before the engine is shut down? • When starting an engine equipped with a Hamilton-Standard counterweight propeller, why should the engine oil pressure be stabilized before shifting the propeller to low pitch?

Activities	*Check Items*
	Did the student:
Describe the operation and control of a counterweight propeller.	• Correctly interpret information? • Use correct nomenclature throughout the description?

DESCRIBE THE OPERATION AND CONTROL OF A HYDROMATIC PROPELLER.

(SEGMENT F, LEVEL 2)

Student Performance Goal

- **Given:**
  A hydromatic type propeller, cutaway or mock-up and written reference information or manual describing the operation of the propeller.

- **Performance:**
  The student will interpret information contained in the reference publications and describe the operation and control of a hydromatic type propeller.

- **Standard:**
  Information will be interpreted without error. Correct nomenclature will be used throughout the explanation and description of operation and control.

Key Points	*Feedback*
Operation of hydromatic propellers.	• What force is used to move the blades toward low pitch? • What force or forces move the blades toward high pitch? • How is the hydromatic propeller put into a full feather pitch position? • What is the approximate oil pressure required to unfeather the hydromatic propeller?
Servicing hydromatic propellers.	• Where do oil leaks normally occur in the hydromatic propeller? • How are hydromatic propellers lubricated? • What are some of the electrical problems normally associated with the hydromatic propeller and its governor?

Activities	*Check Items*
	Did the student:
Describe the operation and control of hydromatic propellers.	• Correctly interpret the reference information? • Use correct nomenclature throughout the description and explanation?

DESCRIBE THE OPERATION AND CONTROL OF NON-COUNTERWEIGHT VARIABLE PITCH, FEATHERING, AND REVERSING PROPELLERS.

(SEGMENT G, LEVEL 2)

Student Performance Goal

- **Given:**
  Diagrams, drawings, cutaways or mock-ups of McCauley, Hartzell, Aeromatic or other variable pitch, feathering and reversing propellers and written reference information or manuals describing the operation and control of these types of propellers.

- **Performance:**
  The student will interpret information contained in the reference publications and describe the operation and control of at least one of the types of propellers.

- **Standard:**
  Information will be interpreted without error. Correct nomenclature will be used throughout the explanation and description of operation and control.

Key Points	*Feedback*
Variable pitch propellers.	• Describe the operation and control of a type of variable pitch propeller which does not have a governor and does not require a propeller control in the cockpit. • What are some of the advantages and disadvantages to the use of electric motor pitch control mechanisms?
Constant speed propellers.	• What will result if the speeder spring on the propeller governor fails or breaks while the engine is operating? • Why do some oil controlled constant speed propellers incorporate a return spring inside the propeller pitch changing mechanism?
Feathering and reversing.	• Why aren't feathering propellers installed on single engine airplanes? • What is the purpose of a feathering propeller? • What is the purpose of reverse thrust? • What safety feature may be incorporated in a reverse thrust propeller to prevent inadvertent propeller reversal?

Activities	*Check Items*
	Did the student:
Describe the operation and control of one of the above described propellers.	• Correctly interpret the reference information? • Use correct nomenclature and terminology?

DESCRIBE THE OPERATION AND CONTROL OF A TURBINE ENGINE PROPELLER SYSTEM.

(SEGMENT H, LEVEL 2)

Student Performance Goal

- **Given:**
  Diagrams, drawings, cutaways or mock-ups of the system and components of a turbine engine propeller and written reference information or manuals describing the operation and control of these propellers.

- **Performance:**
  The student will interpret information contained in the reference publications and describe the operation and control of the propeller on at least one model of turbine powered airplane.

- **Standard:**
  Information will be interpreted without error. Correct nomenclature will be used throughout the explanation and description of operation.

Key Points	*Feedback*
Operation of turbine props.	• In what way does a turbine propeller differ from the propellers installed on reciprocating engines? • How is the propeller connected to the turbine engine? • What control forces are used to actuate the propeller? • How is reverse thrust accomplished on a turbo-prop installation?

Activities	*Check Items* Did the student:
Describe the operation and control of a turbine propeller.	• Correctly interpret the reference information? • Use correct nomenclature and terminology as a part of the explanation and description of operation and control?

INSPECT AND IDENTIFY PROBABLE LOCATION OF DEFECTS IN THE METAL TIPPING OF PROPELLERS.

(SEGMENT I, LEVEL 2)

Student Performance Goal

- Given:
A wood propeller with metal tipping, written reference publications which specify the limiting defects to wooden propellers.

- Performance:
The student will inspect the tipping of the propeller, interpret the specifications contained in the reference publications and describe the probable location and acceptability of defects.

- Standard:
Reference information will be interpreted without error. Any defects which do not meet return-to-service standards will be identified as a result of the inspection.

Key Points	*Feedback*
Propeller tipping.	• Why are the propeller tips more susceptible to damage than other portions of the blade? • What methods have been developed to limit damage to the blade tips during ground operation of the engine? • Why are small holes drilled in the tips of wooden propellers?
Inspection of tipping.	• What materials are generally used for the metal tipping of propeller blades? • Where are cracks most likely to occur in the metal tipping? • As the screws which attach the tipping are soldered to the tipping, how may loose screws be detected? • How may loose tipping be detected? • How is the metal tipping attached to the blade at the very tip of each blade?

Activities	*Check Items* Did the student:
Inspect the metal tipping on a propeller and identify defects.	• Correctly interpret and apply the specifications contained in the reference information? • Use correct nomenclature and describe the most probable location of defects?

SMOOTH NICKS, CUTS, AND SCRATCHES IN THE LEADING AND TRAILING EDGES OF METAL PROPELLER BLADES.

(SEGMENT J, LEVEL 3)

Student Performance Goal

- Given:
Sample serviceable and non-serviceable metal propellers, blades and hubs; AC 43.13-1, manufacturer's manual or equivalent written information describing the repair of nicks, scratches, and similar minor propeller repairs.

- Performance:
The student will inspect and correctly judge whether the propeller meets return-to-service standards. He will smooth nicks, cuts and scratches in the leading and trailing edges of metal propeller blades.

- Standard:
All procedures will be in accordance with the written reference information.

Key Points	*Feedback*
Inspection of steel blades and other steel components.	• What inspection methods are most generally used to inspect steel propeller parts? • Where would a mechanic locate information which would describe the procedure, limits, and defects applicable to a propeller inspection?

	•If a crack is detected in a steel propeller component, what action must be taken?
Inspection of aluminum propellers and propeller blades.	•Describe the procedure that is described as "local etching." •How does a crack appear as it is detected by etching? •What chemical is used to neutralize the action of etching?
Smoothing of nicks, cuts and scratches.	•What reference information would a mechanic use to determine the limits applicable to the profiling of a nick in a propeller blade? •How does the location of the nick or cut influence the smoothing of the defect? •Who is authorized to cold straighten aluminum alloy propellers?

Activities	*Check Items* Did the student:
Inspect metal propellers.	•Correctly interpret and apply the specifications contained in the references?
Smooth nicks, cuts and scratches in the leading edge and trailing edges.	•Follow the procedures and achieve a result that conformed to specifications?

26. INSTALL, TROUBLESHOOT AND REMOVE PROPELLERS. (EIT = 20.50 hrs., T = 7½ hrs., L/S = 13 hrs.) 6 segments

(UNIT LEVEL 3)

CHECK OPERATION OF A FULL FEATHERING AND REVERSING PROPELLER.

(SEGMENT A, LEVEL 3)

Student Performance Goal

- Given:
  An operational engine equipped with a full feathering, reversing propeller; and written operating instructions.

- Performance:
  The student will operate the engine and check the propeller for full feather and reverse pitch operation. He will explain the operation and function of feathering and reversing systems.

- Standard:
  All procedures and explanations will be in accordance with the written operating instructions.

Key Points	*Feedback*
Feathering propeller systems.	•Why is feathering a propeller important in the event of engine failure? •What components are necessary to the operation of a feathering system? •At what power setting should a feathering system be checked for operation?
Reversing propeller systems.	•What limits the low pitch angle of a reversing propeller? •What are the advantages and limitations of a reversing propeller system? •What engine safety precautions should be taken when operating a reversing propeller on ground check?

Activities	*Check Items* Did the student:
Operate the engine and check the propeller for full feather and reverse operation. Describe the operation and function of the propeller systems.	•Correctly interpret information and follow the correct procedure during operation? •Observe safety precautions? •Use correct nomenclature and terminology as a part of the explanation and description?

REMOVE AND INSTALL A PROPELLER ON A TAPERED SHAFT.

(SEGMENT B, LEVEL 3)

Student Performance Goal

- Given:
  An engine or mock-up provided with a tapered propeller shaft, a propeller and hub for a tapered shaft, propeller key, snap ring; written reference information or manuals describing the procedure for checking the contact areas between shaft and propeller hub; service manuals specifying the procedure and torque values for installation of the propeller.

- Performance:
  The student will remove the propeller from the shaft. He will check the contact between the tapered propeller shaft and the hub and reinstall the propeller.

- Standard:
  The procedures specified will be followed without error or omission. The installed propeller will meet return-to-service standards.

Key Points	*Feedback*
Removal of propellers.	• Where would a mechanic find information describing the removal and installation of a specific type of propeller? • What is the function of the snap ring at the front of the hub on a tapered shaft propeller?
Contact between propeller hub and tapered propeller shaft.	• How much contact area is desired between the propeller hub and the tapered shaft? • How would a mechanic determine the contact that exists between propeller hub and tapered shaft? • What material is used to check the contact area?
Installation of propellers.	• What is done to the propeller shaft and hub before installation? • What is the purpose of the propeller hub key? • Where would a mechanic find specifications which describe the torque values to be followed?

Activities	*Check Items* Did the student:
Remove, check propeller hub to shaft contact, and install the propeller.	• Use, correctly interpret specifications, and follow the written instructions? • Achieve and maintain standards that would permit return-to-service • Demonstrate proper regard for safety?

REMOVE AND INSTALL A PROPELLER ON A SPLINED SHAFT.

(SEGMENT C, LEVEL 3)

Student Performance Goal

- Given:
  An engine or mock-up provided with a splined propeller shaft, a propeller of a type approved for installation on this shaft; written reference information or service manuals describing the procedure, torque values and tools required for installation and removal of the propeller.

- Performance:
  The student will remove and reinstall the propeller on the shaft.

- Standard:
  The procedures specified in the reference information will be followed without error or omission. The installed propeller will meet return-to-service standards.

Key Points	*Feedback*
Removal of splined hub propellers.	• At what point during the removal of the propeller should the hub snap ring be removed? • Where would a mechanic find information describing the procedure to be followed during removal and installation of a propeller? • Why are some front cones made in two pieces? • What precautions should be taken to avoid damage to the threaded portion of the propeller shaft?
Installation of splined hub propellers.	• What is the purpose of the front and rear cones on a splined propeller shaft? • Why is it sometimes necessary to remove material from a rear cone or to install a spacer behind the rear cone? • How is the installation checked for possible bottoming of the cones?

Activities	*Check Items* Did the student:
Remove and reinstall a propeller on a splined shaft.	• Use and correctly interpret instructions from the reference information and manuals? • Follow the correct procedures and achieve a standard that would permit return-to-service? • Observe necessary safety precautions during removal and installation?

CHECK TRACK OF A PROPELLER.

(SEGMENT D, LEVEL 3)

Student Performance Goal

- **Given:**
  A fixed pitch propeller and a variable pitch propeller mounted on engines or propeller shaft mock-ups; written information describing the procedure for determining the track of a propeller and the manual specifying the limits applicable to each type of propeller.

- **Performance:**
  The student will check the track of both propellers and using the specifications appearing in the manual will judge whether the propeller meets return-to-service standards.

- **Standard:**
  The procedures will be interpreted and followed without error or omission. The judgement of flight standard and application of tracking limits will be accurate within the limits of the measuring methods used.

Key Points	*Feedback*
Measurement of track.	• At what position on the propeller blade is the track measured? • Where would a mechanic find information pertaining to the maximum out-of-track limits? • Describe a procedure that will permit measurement of the track of a propeller.
Factors effecting track.	• What misalignment will probably produce an out-of-track condition on a flange type fixed pitch propeller? • What are some of the conditions that will result in out-of-track for a flange mounted constant speed propeller? • What would probably cause out-of-track on a spline type propeller? • If a propeller is re-positioned in an effort to achieve correct track, how may this create engine vibration problems? • How is the position of a propeller on the shaft important if the engine is to be hand propped?

Activities	*Check Items* Did the student:
Check the track of both types of propellers.	• Use and correctly interpret instructions from the reference information and manuals? • Follow the correct procedure and correctly judge the track of the propeller?

EXTERNALLY ADJUST AND RIG A PROPELLER GOVERNOR.

(SEGMENT E, LEVEL 3)

Student Performance Goal

- **Given:**
  An operational engine mounted in an airplane or test stand and equipped with a propeller governor and constant speed propeller; written operating instructions and procedures describing the rigging of propeller governor controls and the adjustment of the propeller governor stops.

- **Performance:**
  The student will check the operation of the propeller and propeller governor. He will adjust the rigging of the governor controls and the governor after the instructor has introduced a fault into the propeller governor adjustment or control rigging.

- **Standard:**
  All operations and procedures will be in accordance with the written reference information. The propeller governor and controls following adjustment will function as it was designed to operate and will be within the limits established in the written instructions.

Key Points	*Feedback*
Propeller governor controls.	•How would a loose cable to the governor effect the propeller control? •How could a mechanic determine the correct cable tension necessary in the propeller governor control system? •When inspecting a propeller governor control, what specific items should be checked on the cable turnbuckles, pulleys and bellcranks?
Governor adjustment.	•What mechanical adjustments are possible on the governor? •If the propeller control lever at the pilot's control quadrant is not correctly positioned, what adjustment is necessary? •What reference information will assist the mechanic in identifying the high and low pitch stops on the governor?

Activities	*Check Items*
	Did the student:
Operate the engine and check propeller governor action.	•Use and correctly interpret instruction from the reference information?
Rig and adjust the governor.	•Follow the correct procedures and achieve an adjustment that was within prescribed tolerance? •Observe safety precautions?

TROUBLESHOOT DESCRIPTIONS OF FAULTS IN A HYDROMATIC PROPELLER.

(SEGMENT F, LEVEL 3)

Student Performance Goal

- Given:

  Reference manuals, publications and ten written descriptions of conditions that are related to oil leaks at the rear cone, piston dome seal, blade butts; malfunctions of the pitch changing mechanism or governor control rigging; and a matching list of most probable causes for the malfunction.

- Performance:

  The student will interpret reference information and associate the described condition and the most probable cause.

- Standard:

  The student will correctly associate the most probable cause with the described condition in seven of the ten examples.

Key Points	*Feedback*
Oil leaks.	•Where are the oil seals located in a hydromatic propeller? •What reference information is available to a mechanic as an aid in troubleshooting propeller faults? •Is it necessary to remove the propeller in order to replace the front seal? •How will a leaking piston to dome seal effect propeller operation?
Operational symptoms or malfunctions.	•What is a surging engine? How may a propeller be associated with this problem? •What propeller problem may be associated with an engine that fails to reach full RPM? •What propeller problem may be associated with an engine that over-revs on takeoff? •If a pilot reports that an engine will not maintain an established RPM and requires constant adjustment during flight, what propeller problem may exist?

Activities	*Check Items*
	Did the student:
Associate or match the probable cause with the ten described propeller faults or malfunctions.	•Use and correctly interpret information from the reference manuals? •Use correct nomenclature and terminology? •Correctly judge seven of the described problems?

27. INSPECT, CHECK, SERVICE AND REPAIR PROPELLER SYNCHRONIZING AND ICE CONTROL SYSTEMS.

(EIT = 8 hrs., T = 8 hrs., L/S = 0 hrs.) **2 segments**

(UNIT LEVEL 1)

IDENTIFY COMPONENTS AND DESCRIBE THE OPERATION OF PROPELLER ANTI-ICING SYSTEMS.

(SEGMENT A, LEVEL 1)

Student Performance Goal

- Given:
  Reference information and drawings or diagrams describing alcohol, chemical and thermal types of propeller anti-icing systems; sample components including alcohol reservoirs, pumps and slinger rings; samples of brush blocks, slip rings and thermal boots.
- Performance:
  The student will identify the components, locate information pertaining to the system in the reference publications and describe the operation of each type of anti-icing system.
- Standard:
  The student will correctly identify the components and use correct nomenclature as a part of the description.

Key Points	*Feedback*
Ice formation.	• What are the conditions that cause rapid formation of ice on the propellers of an airplane? • Where does the ice first form? • What is the effect of ice formation on the spinner of a propeller?
Alcohol anti-icing systems.	• What units comprise the alcohol anti-icing system? • What is the approximate composition of the liquid used in an alcohol system? Why is pure alcohol used? • What is the purpose of the slinger ring? • Why do the propeller blade shanks often have a rubber boot when the propeller is equipped with alcohol anti-icing?
Thermal anti-icing systems.	• As the electric boot requires electrical power to develop heat, how is the power conducted from the non-rotating engine nose case to the rotating propeller? • Approximately how much power is required for this type of anti-icing system? • How are the thermal boots attached to the propeller blade shanks?

LOCATE REFERENCE INFORMATION AND DESCRIBE THE OPERATION OF PROPELLER SYNCHRONIZING SYSTEMS.

(SEGMENT B, LEVEL 1)

Student Performance Goal

- Given:
  Reference information describing the operation of a propeller synchronizing system and suitable diagrams or drawings illustrating the location of components within the system.
- Performance:
  The student will locate reference information and describe the operation of a propeller synchronizing system.
- Standard:
  The student will correctly identify the components necessary to the system and use correct nomenclature as a part of the description of operation.

Key Points	*Feedback*
Propeller synchronization.	• What is meant by the term "synchronization"? • What is a resonant vibration or "beat"? • Is the vibration caused by propellers out of synchronization merely an annoyance or is it also destructive? • How will the operator become aware of a defective synchronization system?
Synchronization systems.	• What unit of a propeller system controls the RPM of an engine if the aircraft is equipped with a constant speed propeller?

	•When multi-engined airplanes are equipped with synchronization systems, what is the function of the master engine with respect to synchronizing the other engines? •What is implied by the term "slaved" governor? •What is the purpose of the governor step motor in a synchronizer system?

28. IDENTIFY AND SELECT PROPELLER LUBRICANTS. (EIT = 2 hrs., T = 1 hr., L/S = 1 hr.) 1 segment

(UNIT LEVEL 2)

IDENTIFY THE LUBRICANT TO BE USED TO SERVICE A SPECIFIC PROPELLER.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
Manufacturer's manuals or other reference information specifying the kind of lubricant recommended for use on four specific makes and models of propellers; a data sheet to be completed with information obtained from the manuals or reference information.

- Performance:
The student will locate and interpret information in the reference publications for each of the four propellers and will list the correct lubricant and special procedures that need to be considered in lubricating each model of propeller.

- Standard:
Reference specifications will be interpreted without error.

Key Points	*Feedback*
Proper lubricants.	•Describe how centrifugal forces acting on a propeller make the consistency of a lubricant a matter of importance. •Why must propeller lubricants have reasonably wide temperature ranges? •Due to the high bearing loads, explain why a propeller lubricant must have special antifriction and plasticity characteristics.
Manufacturer's specifications and recommendations.	•Where will information identifying the recommended propeller lubricants be found? •Why do the specifications generally provide alternate brands and trade names for specifically recommended lubricants? •What precautions should be observed with regard to mixing approved lubricants? •Why is the quantity of lubricant also specified as a part of the recommended kind of lubricant?

Activities	*Check Items*
	Did the student:
Use the manufacturers' manuals. Complete data sheet.	•Locate appropriate reference material as listed. •Select the proper lubricant for each propeller. •Identify the correct applicator. •List the special procedures to be observed in performing the lubrication job for each of the propellers.

29. BALANCE PROPELLERS. (EIT = 6½ hrs., T = 2½ hrs., L/S = 4 hrs.) 1 segment

(UNIT LEVEL 2)

INTERPRET INFORMATION AND DESCRIBE THE PROCEDURE FOR BALANCING FIXED PITCH AND VARIABLE PITCH PROPELLERS.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- Given:
Manufacturer's manuals containing information describing the balancing of fixed pitch metal propellers, fixed pitch wood propellers and controllable pitch propellers.

- Performance:
The student will locate and interpret information in the manuals and describe the procedure for balancing one propeller of each type.

- **Standard:**
Information will be interpreted without error. Correct nomenclature and terminology will be used as a part of each description and explanation.

Key Points	*Feedback*
Importance of balance.	• How will an unbalanced propeller effect engine operation? • How could a mechanic distinguish between an out-of-balance condition and a propeller that is out-of-track? • How do worn or improperly torqued engine shock mounts amplify an out-of-balance condition?
Balancing procedures for specific propellers.	• Where would a mechanic locate information which describes the balancing procedure applicable to a specific propeller? • What is the difference between horizontal and vertical balance of a propeller? • In general, how is horizontal balance achieved on fixed pitch propellers? • Why are hollow barrel bolts used on some kinds of propellers? • How does the specialist employed in the propeller overhaul shop detect horizontal and vertical out-of-balance conditions?

Activities	*Check Items*
	Did the student:
Describe the procedure for balancing a fixed pitch and controllable pitch propeller.	• Use and correctly interpret information from the manuals? • Use correct nomenclature and terminology as a part of the explanation and description of procedure?

30. REPAIR PROPELLER CONTROL SYSTEM COMPONENTS. (EIT = 8 hrs., T = 3 hrs., L/S = 5 hrs.) 2 segments

(UNIT LEVEL 2)

DESCRIBE THE ACTION OF A PROPELLER GOVERNOR AND THE FORCES WHICH CONTROL PROPELLER PITCH.

(SEGMENT A, LEVEL 2)

Student Performance Goal

- **Given:**
A propeller governor equipped with a manual control and a governor equipped with an electric control head; manufacturer's manuals describing the operation of each type of propeller; diagrams or drawings illustrating the relationship of governor action to propeller pitch.

- **Performance:**
The student will interpret information from the manuals and point to the control, passageway or portion of the governor that provides propeller control during on-speed, under-speed and over-speed operating conditions. He will describe the governor action which controls propeller pitch and engine speed.

- **Standard:**
Interpretation of information will be without error. Correct nomenclature and terminology will be used as a part of the description and explanation.

Key Points	*Feedback*
Governor action.	• How are the flyweights of the governor driven? • How does the position of the flyweights effect the position of the governor pilot valve? • How is the force acting against the speeder spring in the governor varied or changed? • Why does a governor incorporate an oil pump?
Engine operating conditions.	• What is meant by the terms on-speed, under-speed and over-speed? • How does an increase in propeller pitch effect engine RPM? • How does a decrease in propeller pitch effect engine RPM? • If the propeller quadrant control in the cockpit is marked "increase RPM" in which direction is the propeller pitch moving? • What reference publication would a mechanic use to determine the make and model of governor approved for use with a specific propeller?

Activities	*Check Items*
	Did the student:
Identify the component parts, passageways and controls of a governor.	•Correctly interpret information from the reference publications?
Describe the governor action and the forces controlling propeller pitch.	•Use correct nomenclature and terminology as a part of the description?

PERFORM THE OPERATION NECESSARY TO MATCH DIRECTION OF GOVERNOR ROTATION TO THE ROTATION OF THE ENGINE DRIVE.

(SEGMENT B, LEVEL 2)

Student Performance Goal

- Given:
  A propeller governor assembled for either clockwise or counterclockwise rotation; an engine with a governor drive pad, appropriate reference information describing the procedure necessary to change the direction of rotation of the governor.

- Performance:
  The student will determine the direction of rotation of the governor drive on the engine. He will accomplish the procedure necessary to match the direction of governor rotation to the direction of the engine drive and mount the governor on the engine.

- Standard:
  The procedure specified in the reference information will be followed without exception. The direction of governor drive will match the engine drive, and provide a standard that would permit safe and satisfactory operation of the units.

Key Points	*Feedback*
Direction of governor rotation.	•Why are governors designed to rotate both clockwise and counterclockwise? •Why are the plugs which block the passageways in the governor called oil control plugs? •When a governor is described as clockwise or counterclockwise direction of rotation, how must the governor be viewed?
Governor engine drive pads.	•Where are the propeller governors located on the engine? •How could a mechanic determine the direction of rotation of the engine drive? •What reference information would a mechanic use to determine the procedure to be followed when mounting a governor on an engine?

Activities	*Check Items*
	Did the student:
Determine the direction of rotation of the governor drive and match governor to this direction.	•Use and correctly interpret information from the reference publications?
	•Follow the procedures specified in the manual?
Mount the governor on the engine.	•Achieve a standard which would permit operation of the system?

CHAPTER IV

INSTRUCTIONAL TIME ALLOTMENT

Participants at the last five workshops reviewed the instructional units and estimated the time needed to teach each of the units. In addition, they developed a suggested teaching sequence. Because the instructional patterns of the many schools throughout the nation are quite diverse, the research team decided that sequencing should be the prerogative of each school. Thus, the ensuing tables contain only one of many possible teaching sequences.

The time allotments for the Airframe and Powerplant Curriculums total 1480 hours, 740 hours for each, and the General Curriculum totals 395 hours. The remaining 25 hours (General, 5 hours; Airframe, 10 hours; and Powerplant, 10 hours) were set aside for review, additional practice, and/or examinations.

TABLE 1
DIVISION OF THEORY AND LABORATORY/SHOP HOURS
FOR EACH OF THE CURRICULUM AREAS

Curriculum Area	Hours		Percent	
	Theory	Lab/Shop	Theory	Lab/Shop
General	188.50	206.50	47.72	52.28
Airframe	310.50	429.50	41.96	58.04
Powerplant	322.00	418.00	43.51	56.49
TOTAL	821	1054	43.79	56.21

The division between theory and laboratory/shop hours is shown in Table 1. The total hours shown in Table 1 is 1875. This is 25 hours less than the 1900 hour requirement set by FAR 147, but, as indicated above, these hours were set aside to be used most appropriately. The time allotments for theory and laboratory/shop classes fall within the time limits established for each by FAR 147.

Two different suggested time allotment tables have been developed for each of the five curriculum areas. One type of table is titled Sequential and the other Repetitive. Both types of table subdivide the activities for each instructional unit into theory and laboratory/shop. In the sequential tables, each instructional unit is presented as one time block and any activities relating to that unit's theory and laboratory/shop are to be accomplished within this one time block. No additional time is provided during the remainder of the course to practice or delve further into the instructional unit. In the repetitive tables, however, total time for each instructional unit is distributed such that activities relating to each unit's theory and laboratory/shop may be repeated as many as four times throughout the course. The total time allotted to each instructional unit is the same in both tables; the only difference is in the distribution of this time. For the sequential method, each instructional unit is taught once and in one time block during the course; for the repetitive method, each instructional unit may be taught a number of times in several time blocks throughout the course.

The sequential tables are read by following each item from the top of the table to the bottom. The instructional units are identified by number, beginning with number one and continuing through the last instructional unit. Instructional time is indicated for theory, laboratory/shop, total hours for both theory and laboratory/shop, and cumulative hours.

The repetitive tables are also read from top to bottom, however, they require that each column (instructional series) be read in its entirety before going on to the next. In either type of table, the sequence of instructional units may be rearranged by taking out the entry for an entire unit and inserting that entry in the new position. However, the cumulative hours would then have to be recalculated.

TABLE 1

GENERAL CURRICULUM – SEQUENTIAL TABLE

	Theory	Lab/Shop	Total	Cumulative
MATHEMATICS				
1. Extract roots and raise number to a given power.	3	0	3	3
2. Determine areas and volumes of various geometrical shapes.	4	2	6	9
3. Solve ratio, proportion, and percentage problems.	3	2	5	14
4. Perform algebraic operations involving addition, subtraction, multiplication, and division of positive and negative numbers.	3	3	6	20
AIRCRAFT DRAWINGS				
5. Use drawings, symbols and schematic diagrams.	7	7	14	34
6. Draw sketches of repairs and alterations.	4	6	10	44
7. Use blueprint information.	5	6	11	55
8. Use graphs and charts.	1	2	3	58
BASIC PHYSICS				
9. Use the principles of simple machines: sound, fluid, and heat dynamics.	6	2	8	66
BASIC ELECTRICITY				
10. Determine the relationship of voltage, current, and resistance in electrical circuits.	14	12-1/2	26-1/2	92-1/2
11. Measure voltage, current, resistance, continuity, and leakage.	4	3	7	99-1/2
12. Measure capacitance and inductance.	4	0	4	103-1/2
13. Calculate and measure electrical power.	2	0	2	105-1/2
14. Read and interpret electrical circuit diagrams.	3	3	6	111-1/2
15. Inspect and service batteries.	5-1/2	4-1/2	10	121-1/2
16. Overhaul aircraft electrical components.	12-1/2	10-1/2	23	144-1/2

	Theory	Lab/Shop	Total	Cumulative
FLUID LINES & FITTINGS				
17. Fabricate and install rigid and flexible fluid lines and fittings.	8-1/2	16-1/2	25	169-1/2
MATERIALS & PROCESSES				
18. Perform precision measurements.	2	10	12	181-1/2
19. Identify and select aircraft hardware and materials.	21	17	38	219-1/2
20. Perform basic heat-treating processes.	5	1	6	225-1/2
21. Perform penetrant, chemical etching, and magnetic particle inspections.	4	8-1/2	12-1/2	238
22. Inspect and check welds.	1	4	5	243
23. Identify and select appropriate non-destructive testing methods.	7	0	7	250
CLEANING & CORROSION CONTROL				
24. Identify and select cleaning materials.	4	8	12	262
25. Perform aircraft cleaning and corrosion control.	8	18	26	288
GROUND OPERATION & SERVICING				
26. Identify and select fuels.	2-1/2	1-1/2	4	292
27. Start, ground operate, move, service, and secure aircraft.	8	18	26	318
MAINTENANCE PUBLICATIONS				
28. Select and use FAA and manufacturer's aircraft maintenance specifications, data sheets, manuals, publications, and related Federal Aviation Regulations.	6-1/2	6-1/2	13	331
29. Read technical data.	3	3	6	337
MECHANIC PRIVILEGES & LIMITATIONS				
30. Exercise mechanic privileges within the limitations prescribed by FAR 65.	2	3	5	342
MAINTENANCE FORMS & RECORDS				
31. Write description of aircraft condition and work performed.	2	3	5	347
32. Complete required maintenance forms, records, and inspection reports.	6-1/2	1-1/2	8	355

	Theory	Lab/Shop	Total	Cumulative
AIRCRAFT WEIGHT & BALANCE				
33. Weigh aircraft.	4-1/2	8-1/2	13	368
34. Perform complete weight and balance check and record data.	12	15	27	395
TOTAL	188-1/2	206-1/2	395	395

TABLE 2

GENERAL CURRICULUM – REPETITIVE TABLE

	Series 1				Series 2				Series 3				Series 4			
	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
MATHEMATICS																
1. Extract roots and raise number to a given power.	3	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
2. Determine areas and volumes of various geometrical shapes.	4	2	6	9	-	-	-	-	-	-	-	-	-	-	-	-
3. Solve ratio, proportion, and percentage problems.	3	2	5	14	-	-	-	-	-	-	-	-	-	-	-	-
4. Perform algebraic operations involving addition, subtraction, multiplication, and division of positive and negative numbers.	3	3	6	20	-	-	-	-	-	-	-	-	-	-	-	-
AIRCRAFT DRAWINGS																
5. Use drawings, symbols, and schematic diagrams.	7	7	14	34	-	-	-	-	-	-	-	-	-	-	-	-
6. Draw sketches of repairs and alterations.	4	3	7	41	-	2	2	315.5	-	1	1	368.5	-	-	-	-
7. Use blueprint information.	3	2	5	46	2	2	4	319.5	-	1	1	369.5	-	1	1	388.5
8. Use graphs and charts.	1	1.5	2.5	48.5	-	.5	.5	320	-	-	-	-	-	-	-	-
BASIC PHYSICS																
9. Use the principles of simple machines: sound, fluid, and heat dynamics.	6	2	8	56.5	-	-	-	-	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
BASIC ELECTRICITY																
10. Determine the relationship of voltage, current, and resistance in electrical circuits.	9.5	6	15.5	72	2.5	4.5	7	327	2	1	3	372.5	-	1	1	389.5
11. Measure voltage, current, resistance, continuity, and leakage.	2	1	3	75	1.5	1	2.5	329.5	.5	.5	1	373.5	-	.5	.5	390
12. Measure capacitance and inductance.	4	-	4	79	-	-	-	-	-	-	-	-	-	-	-	-
13. Calculate and measure electrical power.	2	-	2	81	-	-	-	-	-	-	-	-	-	-	-	-
14. Read and interpret electrical circuit diagrams.	1	1	2	83	1	1	2	331.5	1	1	2	375.5	-	-	-	-
15. Inspect and service batteries.	3.5	3.5	7	90	1	1	2	333.5	1	-	1	376.5	-	-	-	-
16. Overhaul aircraft electrical components.	12.5	10.5	23	113	-	-	-	-	-	-	-	-	-	-	-	-
FLUID LINES & FITTINGS																
17. Fabricate and install rigid and flexible fluid lines and fittings.	7	10	17	130	1.5	4	5.5	339	-	1.5	1.5	378	-	1	1	391
MATERIALS & PROCESSES																
18. Perform precision measurements.	2	4	6	136	-	2	2	341	-	2	2	380	-	2	2	393
19. Identify and select aircraft hardware and materials.	17	10	27	163	4	4	8	349	-	2	2	382	-	1	1	394
20. Perform basic heat-treating processes.	5	1	6	169	-	-	-	-	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
MATERIALS & PROCESSES (continued)																
21. Perform penetrant, chemical etching, and magnetic particle inspections.	4	8.5	12.5	181.5	-	-	-	-	-	-	-	-	-	-	-	-
22. Inspect and check welds.	1	2	3	184.5	-	1	1	350	-	1	1	383	-	-	-	-
23. Identify and select appropriate non-destructive testing methods.	7	-	7	191.5	-	-	-	-	-	-	-	-	-	-	-	-
CLEANING & CORROSION CONTROL																
24. Identify and select cleaning materials.	4	5	9	200.5	-	2	2	352	-	1	1	384	-	-	-	-
25. Perform aircraft cleaning and corrosion control.	8	11	19	219.5	-	5	5	357	-	1	1	385	-	1	1	395
GROUND OPERATION & SERVICING																
26. Identify and select fuels.	2.5	1.5	4	223.5	-	-	-	-	-	-	-	-	-	-	-	-
27. Start, ground operate, move, service and secure aircraft.	8	18	26	249.5	-	-	-	-	-	-	-	-	-	-	-	-
MAINTENANCE PUBLICATIONS																
28. Select and use FAA and manufacturer's aircraft maintenance specifications, data sheets, manuals, publications, and related Federal Aviation Regulations.	6.5	5.5	12	261.5	-	.5	.5	357.5	-	.5	.5	385.5	-	-	-	-
29. Read technical data.	2	1	3	264.5	1	1	2	359.5	-	1	1	386.5	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
MECHANIC PRIVILEGES AND LIMITATIONS																
30. Exercise mechanic privileges within the limitations prescribed by FAR 65.	2	2	4	268.5	-	1	1	360.5	-	-	-	-	-	-	-	-
MAINTENANCE FORMS & RECORDS																
31. Write description of aircraft condition and work performed.	2	3	5	273.5	-	-	-	-	-	-	-	-	-	-	-	-
32. Complete required maintenance forms, records, and inspection reports.	6.5	1.5	8	281.5	-	-	-	-	-	-	-	-	-	-	-	-
AIRCRAFT WEIGHT & BALANCE																
33. Weigh aircraft.	4.5	8.5	13	294.5	-	-	-	-	-	-	-	-	-	-	-	-
34. Perform complete weight and balance check and record data.	9	10	19	313.5	3	4	7	367.5	-	1	1	387.5	-	-	-	-

TABLE 3

AIRCRAFT STRUCTURES – SEQUENTIAL TABLE

	Theory	Lab/Shop	Total	Cumulative
WOOD STRUCTURES				
1. Identify wood defects.	1	1	2	2
2. Inspect wood structures.	1-1/2	1-1/2	3	5
3. Service and repair wood structures.	7-1/2	-	7-1/2	12-1/2
FABRIC COVERING				
4. Select and apply fabric and fiberglass covering materials.	3-1/2	-	3-1/2	16
5. Inspect, test, and repair fabric and fiberglass.	4	9	13	29
AIRCRAFT FINISHES				
6. Apply trim, letters, and touchup paint.	2	-	2	31
7. Identify and select aircraft finishing materials.	2	1	3	34
8. Apply paint and dope.	4	18	22	56
9. Inspect finishes and identify defects.	1	2	3	59
SHEET METAL STRUCTURES				
10. Install conventional rivets.	5	16	21	80
11. Install special rivets and fasteners.	5	10	15	95
12. Hand form, lay out, and bend sheet metal.	7	27	34	129
13. Inspect and repair sheet metal structures.	15	29	44	173
14. Inspect bonded structures.	4	5	9	182
15. Inspect and repair plastics, honeycomb, and laminated structures.	3	8	11	193
16. Inspect, check, service, and repair windows, doors, and interior furnishings.	3	9	12	205
WELDING				
17. Solder, braze, and arcweld steel.	7	25-1/2	32-1/2	237-1/2
18. Fabricate tubular structures.	6	-	6	243-1/2
19. Solder stainless steel.	1	-	1	244-1/2

	Theory	Lab/Shop	Total	Cumulative
WELDING (continued)				
20. Weld stainless steel and aluminum.	1/2	3	3-1/2	248
21. Weld magnesium and titanium	2	-	2	250
ASSEMBLY & RIGGING				
22. Rig fixed wing aircraft.	4	5	9	259
23. Rig rotary wing aircraft.	8	-	8	267
24. Check alignment of structures.	2	8	10	277
25. Assemble aircraft.	1	6	7	284
26. Balance and rig movable surfaces.	4	20	24	308
27. Jack aircraft.	1	2	3	311
AIRFRAME INSPECTIONS				
28. Perform 100-hour or annual inspection.	2	18	20	331
TOTAL	107	224	331	331

TABLE 4

AIRCRAFT STRUCTURES – REPETITIVE TABLE

	Series 1				Series 2				Series 3				Series 4			
	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
WOOD STRUCTURES																
1. Identify wood defects.	1	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
2. Inspect wood structures.	1.5	1.5	3	5	-	-	-	-	-	-	-	-	-	-	-	-
3. Service and repair wood structure.	7.5	-	7.5	12.5	-	-	-	-	-	-	-	-	-	-	-	-
FABRIC COVERING																
4. Select and apply fabric and fiberglass covering materials.	3.5	-	3.5	16	-	-	-	-	-	-	-	-	-	-	-	-
5. Inspect, test, and repair fabric and fiberglass.	3	5	8	24	1	3	4	259	-	1	1	$314\frac{3}{4}$	-	-	-	-
AIRCRAFT FINISHES																
6. Apply trim, letters, and touchup paint.	2	-	2	26	-	-	-	-	-	-	-	-	-	-	-	-
7. Identify and select aircraft finishing materials.	2	1	3	29	-	-	-	-	-	-	-	-	-	-	-	-
8. Apply paint and dope.	4	9	13	42	-	9	9	268	-	-	-	-	-	-	-	-
9. Inspect finishes and identify defects.	1	1	2	44	-	1	1	269	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
SHEET METAL STRUCTURES																
10. Install conventional rivets.	4	9	13	57	1	4	5	274	-	3	3	$317\frac{3}{4}$	-	-	-	-
11. Install special rivets and fasteners.	5	10	15	72	-	-	-	-	-	-	-	-	-	-	-	-
12. Hand form, lay out, and bend sheet metal.	4	16	20	92	2	6	8	282	1	3	4	$321\frac{3}{4}$	-	2	2	330
13. Inspect and repair sheet metal structures.	13	15.5	28.5	120.5	1	$10\frac{3}{4}$	$11\frac{3}{4}$	$293\frac{3}{4}$	1	$2\frac{3}{4}$	$3\frac{3}{4}$	325.5	-	-	-	-
14. Inspect bonded structures.	4	5	9	129.5	-	-	-	-	-	-	-	-	-	-	-	-
15. Inspect and repair plastics, honeycomb, and laminated structures.	3	8	11	140.5	-	-	-	-	-	-	-	-	-	-	-	-
16. Inspect, check, service, and repair windows, doors, and interior furnishings.	3	6	9	149.5	-	2	2	$295\frac{3}{4}$	-	1	1	326.5	-	-	-	-
WELDING																
17. Solder, braze, and arcweld steel.	7	25.5	32.5	182	-	-	-	-	-	-	-	-	-	-	-	-
18. Fabricate tubular structures.	6	-	6	188	-	-	-	-	-	-	-	-	-	-	-	-
19. Solder stainless steel.	1	-	1	189	-	-	-	-	-	-	-	-	-	-	-	-
20. Weld stainless steel and aluminum.	.5	3	3.5	192.5	-	-	-	-	-	-	-	-	-	-	-	-
21. Weld magnesium and titanium.	2	-	2	194.5	-	-	-	-	-	-	-	-	-	-	-	-
ASSEMBLY & RIGGING																
22. Rig fixed wing aircraft.	4	5	9	203.5	-	-	-	-	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
ASSEMBLY & RIGGING (continued)																
23. Rig rotary wing aircraft.	8	-	8	211.5	-	-	-	-	-	-	-	-	-	-	-	-
24. Check alignment of structures.	2	8	10	221.5	-	-	-	-	-	-	-	-	-	-	-	-
25. Assemble aircraft.	1	2	3	224.5	-	2	2	$297\frac{3}{4}$	-	1	1	327.5	-	1	1	331
26. Balance and rig movable surfaces.	4	12.5	16.5	241	-	7	7	$304\frac{3}{4}$	-	.5	.5	328	-	-	-	-
27. Jack aircraft.	1	1	2	243	-	1	1	$305\frac{3}{4}$	-	-	-	-	-	-	-	-
AIRFRAME INSPECTIONS																
28. Perform 100-hour annual inspection.	2	10	12	255	-	8	8	$313\frac{3}{4}$	-	-	-	-	-	-	-	-

TABLE 5

AIRCRAFT SYSTEMS AND COMPONENTS – SEQUENTIAL TABLE

	Theory	Lab/Shop	Total	Cumulative
AIRCRAFT ELECTRICAL SYSTEMS				
1. Install, check, and service airframe electrical wiring, controls, switches, indicators, and protective devices.	18-1/2	24	42-1/2	42-1/2
2. Inspect, check, troubleshoot, service, and repair alternating current and direct current electrical systems.	19-1/2	18-1/2	38	80-1/2
3. Repair aircraft electrical system components.	13	11-1/2	24-1/2	105
HYDRAULIC & PNEUMATIC POWER SYSTEMS				
4. Identify and select hydraulic fluids.	1	1	2	107
5. Repair hydraulic and pneumatic power system components.	7	8	15	122
6. Inspect, check, service, troubleshoot, and repair hydraulic, and pneumatic power systems.	25	30	55	177
AIRCRAFT LANDING GEAR SYSTEMS				
7. Inspect, check, service, and repair landing gear, retraction systems, shock struts, brakes, wheels, tires, and steering systems.	32	50	82	259
POSITION & WARNING SYSTEMS				
8. Inspect, check, and service speed- and takeoff-warning systems and antiskid electrical brake controls.	5-1/2	5-1/2	11	270
9. Inspect, check, troubleshoot, service, and repair landing gear position indicating and warning systems.	3	6	9	279
AIRCRAFT INSTRUMENT SYSTEMS				
10. Install instruments.	5	6	11	290
11. Inspect, check, service, troubleshoot, and repair heading, speed, altitude, time, attitude, temperature, pressure, and position indicating systems.	4	5	9	299

	Theory	Lab/Shop	Total	Cumulative
AIRCRAFT FUEL SYSTEMS				
12. Inspect, check, service, troubleshoot, and repair aircraft fuel systems.	6	7	13	312
13. Repair aircraft fuel system components.	5	5	10	322
14. Inspect and repair fuel quantity indicating systems.	3	3	6	328
15. Inspect, check, and repair pressure fueling systems.	2	-	2	330
16. Check and service fuel dump systems.	1	-	1	331
17. Perform fuel management transfer and defueling.	2	-	2	333
18. Troubleshoot, service, and repair fluid pressure and temperature warning systems.	1	1	2	335
COMMUNICATIONS & NAVIGATION SYSTEMS				
19. Inspect, check, and service auto-pilot and approach control systems.	5	-	5	340
20. Inspect, check, and service aircraft electronic communication and navigation systems.	5	-	5	345
21. Inspect and repair antenna and electronic equipment installations.	5	5	10	355
CABIN ATMOSPHERE CONTROL SYSTEMS				
22. Inspect, check, troubleshoot, service and repair heating, cooling, air conditioning, and pressurization systems.	14	-	14	369
23. Inspect, check, troubleshoot, service, and repair oxygen systems.	3	4	7	376
24. Repair heating, cooling, air conditioning, pressurization, and oxygen system components.	9	-	9	385
ICE & RAIN CONTROL				
25. Inspect, check, troubleshoot, service, and repair airframe ice and rain control systems.	4	8	12	397

	Theory	Lab/Shop	Total	Cumulative
FIRE PROTECTION SYSTEMS				
26. Inspect, check, and service smoke and carbon monoxide detection systems.	1	-	1	398
27. Inspect, check, service, troubleshoot, and repair aircraft fire detection and extinguishing systems.	4	7	11	409
TOTAL	203-1/2	205-1/2	409	409

TABLE 6

AIRCRAFT SYSTEMS AND COMPONENTS – REPETITIVE TABLE

	Series 1				Series 2				Series 3				Series 4			
	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
AIRCRAFT ELECTRICAL SYSTEMS																
1. Install, check, and service airframe electrical wiring, controls, switches, indicators, and protective devices.	13.5	22.5	36	36	$4\frac{3}{4}$	1.5	$6\frac{1}{4}$	367	$\frac{1}{4}$	-	$\frac{1}{4}$	409	-	-	-	-
2. Inspect, check, troubleshoot, service, and repair alternating current and direct current electrical systems.	18.5	17.5	36	72	1	1	2	369	-	-	-	-	-	-	-	-
3. Repair aircraft electrical system components.	10	11.5	21.5	93.5	3	-	3	372	-	-	-	-	-	-	-	-
HYDRAULIC & PNEUMATIC POWER SYSTEMS																
4. Identify and select hydraulic fluids.	1	1	2	95.5	-	-	-	-	-	-	-	-	-	-	-	-
5. Repair hydraulic and pneumatic power system components.	6	7	13	108.5	1	1	2	374	-	-	-	-	-	-	-	-
6. Inspect, check, service, troubleshoot and repair hydraulic and pneumatic power systems.	20	20	40	148.5	5	10	15	389	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
AIRCRAFT LANDING GEAR SYSTEMS																
7. Inspect, check, service, and repair landing gear, retraction systems, shock struts, brakes, wheels, tires, and steering systems.	$24\frac{3}{4}$	39.5	$64\frac{1}{4}$	$212\frac{3}{4}$	$7\frac{1}{4}$	10.5	$17\frac{3}{4}$	$406\frac{3}{4}$	-	-	-	-	-	-	-	-
POSITION & WARNING SYSTEMS																
8. Inspect, check, and service speed- and takeoff-warning systems and antiskid electrical brake controls.	5.5	5.5	11	$223\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
9. Inspect, check, troubleshoot, service, and repair landing gear position indicating and warning systems.	3	6	9	$232\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
AIRCRAFT INSTRUMENT SYSTEMS																
10. Install instruments.	5	6	11	$243\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
11. Inspect, check, service, troubleshoot, and repair heading, speed, altitude, time, attitude, temperature, pressure, and position indicating systems.	4	5	9	$252\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
AIRCRAFT FUEL SYSTEMS																
12. Inspect, check, service, troubleshoot, and repair aircraft fuel systems.	6	7	13	$265\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
AIRCRAFT FUEL SYSTEMS (continued)																
13. Repair aircraft fuel system components.	5	5	10	$275\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
14. Inspect and repair fuel quantity indicating systems.	3	3	6	$281\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
15. Inspect, check, and repair pressure fueling systems.	2	-	2	$283\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
16. Check and service fuel dump systems.	1	-	1	$284\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
17. Perform fuel management, transfer, and defueling.	2	-	2	$286\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
18. Troubleshoot, service, and repair fluid pressure and temperature warning systems.	1	1	2	$288\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
COMMUNICATIONS & NAVIGATION SYSTEMS																
19. Inspect, check, and service autopilot and approach control systems.	5	-	5	$293\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
20. Inspect, check, and service aircraft electronic communication and navigation systems.	5	-	5	$298\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
21. Inspect and repair antenna and electronic equipment installations.	5	5	10	$308\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
CABIN ATMOSPHERE CONTROL SYSTEMS																
22. Inspect, check, troubleshoot, service, and repair heating, cooling, air conditioning, and pressurization systems.	12	-	12	$320\frac{3}{4}$	2	-	2	$408\frac{3}{4}$	-	-	-	-	-	-	-	-
23. Inspect, check, troubleshoot, service, and repair oxygen systems.	3	4	7	$327\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
24. Repair heating, cooling, air conditioning, pressurization, and oxygen system components.	9	-	9	$336\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
ICE & RAIN CONTROL																
25. Inspect, check, troubleshoot, service, and repair airframe ice and rain control systems.	4	8	12	$348\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
FIRE PROTECTION SYSTEMS																
26. Inspect, check, and service smoke and carbon monoxide detection systems.	1	-	1	$349\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-
27. Inspect, check, service, troubleshoot, and repair aircraft fire detection and extinguishing systems.	4	7	11	$360\frac{3}{4}$	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 7

POWERPLANT THEORY AND MAINTENANCE – SEQUENTIAL TABLE

	Theory	Lab/Shop	Total	Cumulative
RECIPROCATING ENGINES				
1. Overhaul reciprocating engines.	24	80	104	104
2. Inspect and repair reciprocating engines.	15-1/2	28	43-1/2	147-1/2
3. Inspect, check, service, and repair opposed and radial engines and reciprocating engine installations.	20-1/2	30-1/2	51	198-1/2
4. Install, troubleshoot, and remove reciprocating engines.	15-1/2	24-1/2	40	238-1/2
TURBINE ENGINES				
5. Overhaul turbine engines.	24	10	34	272-1/2
6. Inspect, check, service, and repair turbine engine installations.	5	5	10	282-1/2
7. Install, troubleshoot, and remove turbine engines.	5	5-1/2	10-1/2	293
ENGINE INSPECTION				
8. Perform powerplant conformity and airworthiness inspection.	3	7	10	303
TOTAL	106-1/2	196-1/2	303	303

TABLE 8

POWERPLANT THEORY AND MAINTENANCE – REPETITIVE TABLE

	Series 1				Series 2				Series 3				Series 4			
	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
RECIPROCATING ENGINES																
1. Overhaul reciprocating engines.	24	80	104	104	-	-	-	-	-	-	-	-	-	-	-	-
2. Inspect and repair reciprocating engines.	15.5	28	43.5	147.5	-	-	-	-	-	-	-	-	-	-	-	-
3. Inspect, check, service, and repair opposed and radial engines and reciprocating engine installations.	17	19	36	183.5	3.5	$8\frac{1}{4}$	$11\frac{3}{4}$	$281\frac{3}{4}$	-	$3\frac{1}{4}$	$3\frac{1}{4}$	298	-	-	-	-
4. Install, troubleshoot, and remove reciprocating engines.	13.5	14	27.5	211	2	7.5	9.5	$291\frac{1}{4}$	-	3	3	301	-	-	-	-
TURBINE ENGINES																
5. Overhaul turbine engines.	24	10	34	245	-	-	-	-	-	-	-	-	-	-	-	-
6. Inspect, check, service, and repair turbine engine installations.	5	5	10	255	-	-	-	-	-	-	-	-	-	-	-	-
7. Install, troubleshoot, and remove turbine engines.	5	5.5	10.5	265.5	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE INSPECTION																
8. Perform powerplant conformity and airworthiness inspection.	1.5	3	4.5	270	1.5	2	3.5	$294\frac{3}{4}$	-	2	2	303	-	-	-	-

TABLE 9

POWERPLANT SYSTEMS AND COMPONENTS – SEQUENTIAL TABLE

	Theory	Lab/Shop	Total	Cumulative
LUBRICATION SYSTEMS				
1. Identify and select lubricants.	5	5-1/2	10-1/2	10-1/2
2. Inspect, check, service, troubleshoot, and repair engine lubrication systems.	22	18-1/2	40-1/2	51
3. Repair engine lubrication system components.	11	7	18	69
ENGINE FUEL SYSTEMS				
4. Inspect, check, service, troubleshoot, and repair engine fuel systems.	2	3	5	74
5. Repair engine fuel system components.	3-1/2	5	8-1/2	82-1/2
FUEL METERING SYSTEMS				
6. Inspect, check, service, troubleshoot, and repair reciprocating and turbine engine fuel metering systems.	13	17	30	112-1/2
7. Overhaul carburetors.	12	8	20	132-1/2
8. Repair engine fuel metering system components.	3	3	6	138-1/2
9. Inspect, check, and service water injection systems.	2	-	2	140-1/2
INDUCTION SYSTEMS				
10. Inspect, check, troubleshoot, service, and repair engine ice and rain control systems.	2	2-1/2	4-1/2	145
11. Inspect, check, service, and repair heat exchangers and superchargers.	4	3-1/2	7-1/2	152-1/2
12. Inspect, check, service, and repair carburetor air intake and induction manifolds.	2-1/2	4	6-1/2	159
ENGINE COOLING SYSTEMS				
13. Inspect, check, troubleshoot, service, and repair engine cooling systems.	3	4	7	166
14. Repair engine cooling system components.	-1/2	2-1/2	3	169

	Theory	Lab/Shop	Total	Cumulative
ENGINE EXHAUST SYSTEMS				
15. Inspect, check, troubleshoot, service, and repair engine exhaust systems.	6	7	13	182
16. Repair engine exhaust system components.	2	2	4	186
IGNITION SYSTEMS				
17. Overhaul magneto and ignition harness.	15	15	30	216
18. Inspect, check, service, troubleshoot, and repair reciprocating and turbine engine ignition systems.	12	20	32	248
19. Repair engine ignition system components.	14	14	28	276
ENGINE ELECTRICAL SYSTEMS				
20. Install, check, and service engine electrical wiring, controls, switches, indicators, and protective devices.	18-1/2	19-1/2	38	314
21. Repair engine electrical system components.	11	8-1/2	19-1/2	333-1/2
ENGINE INSTRUMENT SYSTEMS				
22. Inspect, check, service, troubleshoot, and repair engine temperature, pressure, and RPM indicating systems.	11	7	18	351-1/2
23. Troubleshoot, service, and repair fluid rate of flow indicating systems.	2	-1/2	2-1/2	354
ENGINE FIRE PROTECTION SYSTEMS				
24. Inspect, check, service, troubleshoot, and repair engine fire detection and extinguishing systems.	2-1/2	2-1/2	5	359
PROPELLERS				
25. Inspect, check, service, and repair fixed-pitch, constant-speed, and feathering propellers and propeller governing systems.	14	19	33	392
26. Install, troubleshoot, and remove propellers.	7-1/2	13	20-1/2	412-1/2
27. Inspect, check, service, and repair propeller synchronizing and ice control systems.	8	-	8	420-1/2
28. Identify and select propeller lubricants.	1	1	2	422-1/2

	Theory	Lab/Shop	Total	Cumulative
PROPELLERS (continued)				
29. Balance propellers.	**2-1/2**	**4**	**6-1/2**	**429**
30. Repair propeller control system components.	**3**	**5**	**8**	**437**
TOTAL	**215-1/2**	**221-1/2**	**437**	**437**

TABLE 10

POWERPLANT SYSTEMS AND COMPONENTS – REPETITIVE TABLE

	Series 1				Series 2				Series 3				Series 4			
	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
LUBRICATION SYSTEMS																
1. Identify and select lubricants.	5	5.5	10.5	10.5	-	-	-	-	-	-	-	-	-	-	-	-
2. Inspect, check, service, troubleshoot, and repair engine lubrication systems.	17	13	30	40.5	4	$4\frac{1}{4}$	$8\frac{1}{4}$	$382\frac{1}{4}$	1	$1\frac{1}{4}$	$2\frac{1}{4}$	425.5	-	-	-	-
3. Repair engine lubrication system components.	11	7	18	58.5	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE FUEL SYSTEMS																
4. Inspect, check, service, troubleshoot, and repair engine fuel systems.	2	1.5	3.5	62	-	1.5	1.5	$383\frac{3}{4}$	-	-	-	-	-	-	-	-
5. Repair engine fuel system components.	3.5	5	8.5	70.5	-	-	-	-	-	-	-	-	-	-	-	-
FUEL METERING SYSTEMS																
6. Inspect, check, service, troubleshoot, and repair reciprocating and turbine engine fuel metering systems.	10	13	23	93.5	3	3	6	$389\frac{3}{4}$	-	1	1	426.5	-	-	-	-
7. Overhaul carburetors.	12	8	20	113.5	-	-	-	-	-	-	-	-	-	-	-	-
8. Repair engine fuel metering system components.	3	3	6	119.5	-	-	-	-	-	-	-	-	-	-	-	-
9. Inspect, check, and service water injection systems.	2	-	2	121.5	-	-	-	-	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
INDUCTION SYSTEMS																
10. Inspect, check, troubleshoot, service, and repair engine ice and rain control systems.	2	2.5	4.5	126	-	-	-	-	-	-	-	-	-	-	-	-
11. Inspect, check, service, and repair heat exchangers and superchargers.	4	3.5	7.5	133.5	-	-	-	-	-	-	-	-	-	-	-	-
12. Inspect, check, service, and repair carburetor air intake and induction manifolds.	2.5	2.5	5	138.5	-	1.5	1.5	$391\frac{1}{4}$	-	-	-	-	-	-	-	-
ENGINE COOLING SYSTEMS																
13. Inspect, check, troubleshoot, service, and repair engine cooling systems.	2.5	2.5	5	143.5	.5	1.5	2	$393\frac{1}{4}$	-	-	-	-	-	-	-	-
14. Repair engine cooling system components.	.5	2.5	3	146.5	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE EXHAUST SYSTEMS																
15. Inspect, check, troubleshoot, service, and repair engine exhaust systems.	6	7	13	159.5	-	-	-	-	-	-	-	-	-	-	-	-
16. Repair engine exhaust system components.	2	2	4	163.5	-	-	-	-	-	-	-	-	-	-	-	-
IGNITION SYSTEMS																
17. Overhaul magneto and ignition harness.	15	15	30	193.5	-	-	-	-	-	-	-	-	-	-	-	-
18. Inspect, check, service, troubleshoot, and repair reciprocating and turbine engine ignition systems.	10	15	25	218.5	2	4	6	$399\frac{1}{4}$	-	1	1	427.5	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
IGNITION SYSTEMS (continued)																
19. Repair engine ignition system components.	14	14	28	246.5	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE ELECTRICAL SYSTEMS																
20. Install, check, and service engine electrical wiring, controls, switches, indicators, and protective devices.	13	13	26	272.5	3.5	4	7.5	$406\frac{3}{4}$	2	2.5	4.5	432				
21. Repair engine electrical system components.	11	8.5	19.5	292	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE INSTRUMENT SYSTEMS																
22. Inspect, check, service, troubleshoot, and repair engine temperature, pressure, and RPM indicating systems.	9	5.5	14.5	306.5	2	1.5	3.5	$410\frac{1}{4}$	-	-	-	-	-	-	-	-
23. Troubleshoot, service, and repair fluid rate of flow indicating systems.	2	.5	2.5	309	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE FIRE PROTECTION SYSTEMS																
24. Inspect, check, service, troubleshoot, and repair engine fire detection and extinguishing systems.	1.5	1.5	3	312	1	1	2	$412\frac{1}{4}$	-	-	-	-	-	-	-	-

	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum	Th	L/S	Tot	Cum
PROPELLERS																
25. Inspect, check, service, and repair fixed-pitch, constant-speed, and feathering propellers and propeller governing systems.	11	12	23	335	2	4	6	$418\frac{1}{4}$	1	3	4	436	-	-	-	-
26. Install, troubleshoot and remove propellers.	6.5	8	14.5	349.5	1	4	5	$423\frac{1}{4}$	-	1	1	437	-	-	-	-
27. Inspect, check, service, and repair propeller synchronizing and ice control systems.	8	-	8	357.5	-	-	-	-	-	-	-	-	-	-	-	-
28. Identify and select propeller lubricants.	1	1	2	359.5	-	-	-	-	-	-	-	-	-	-	-	-
29. Balance propellers.	2.5	4	6.5	366	-	-	-	-	-	-	-	-	-	-	-	-
30. Repair propeller control system components.	3	5	8	374	-	-	-	-	-	-	-	-	-	-	-	-

PART TWO

CHAPTER V

PART 2, PHASE 3 OF THE NATIONAL STUDY OF THE AVIATION MECHANICS OCCUPATION

Two previous studies published in 1966 led to the development of a common core curriculum for the training of aviation mechanics. The studies were A Study of the Aviation Mechanics Occupation in California[1] and A National Study of the Aviation Mechanics Occupation.[2]

The first of these studies surveyed the aviation mechanics occupation in California, and the second expanded the scope of the investigation to the national level. The national study included a survey of six regional areas of the United States. These areas were determined through the use of an industry density pattern in which the heaviest concentration of airline and general aviation activity was identified. The states and the survey areas they formed are listed below:

Area 1 - California, Idaho, Oregon, Washington

Area 2 - Colorado, Kansas, Oklahoma, Texas

Area 3 - Illinois, Iowa, Michigan, Minnesota, Missouri

Area 4 - Florida, Georgia, North Carolina, South Carolina

Area 5 - Maryland, Ohio, Pennsylvania, Washington, D.C.

Area 6 - Connecticut, Massachusetts, New Jersey, New York

With the California survey results added to the data collected during the national survey, a total of 401 companies covering the job activities of 18,080 aviation mechanics was attained. The data collected provided current information on a regional basis in the following industrial categories: airline line, airline overhaul, large general aviation, and small general aviation (companies employing five mechanics or less). The published data and results of the 1965-66 survey were included in Phase 1 of the National Study of the Aviation Mechanics Occupation.

Phase 1 of the National Study provided the detailed information needed to bring the aviation maintenance technician school curriculums up to 1966 requirements.

Part two, Phase 3 of the National Study of the Aviation Mechanics Occupation was designed to (1) identify the changes that had occurred within the industry since the 1965-66 survey, and (2) determine the reliability of specific sampling techniques as a means of identifying changes in the occupation.

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[1] David Allen, Richard Lano, and Norman Witt, A Study of the Aviation Mechanics Occupation in California. Berkeley: University of California Press, 1966, 170 pp.

[2] David Allen, John Meyer, Alvin Gorenbein, and William Bowers, A National Study of the Aviation Mechanics Occupation. Los Angeles: UCLA Press, 1966, 229 pp.

The importance of maintaining instructional content current with changes occurring in the aviation industry cannot be overemphasized. Thus, Part Two, Phase 3 of the National Study is crucial to the entire study since it both updates previous data tests a sampling system that would be inexpensive in terms of cost for large surveys while retaining an acceptable degree of reliability.

Part two, Phase 3 was begun in November 1969, and was concluded in March 1970, at which time final recommendations were made by the National Advisory Committee.

AVIATION INDUSTRY RESURVEY

A field resurvey of the six areas of the United States began on November 1, 1969. The recheck was accomplished by sampling 30 percent of the companies surveyed in 1965 and 1966 during Phase 1 of the National Study. Two questionnaires were used to obtain current industrial statistical information. One was the original questionnaire used in the 1965-1966 survey and the other was a modified questionnaire which provided the respondents with the data findings obtained from the 1966 study. An attempt was made to have an approximately even division in the random use of each questionnaire.

Figure 1. ORIGINAL QUESTIONNAIRE

Hydraulic and Pneumatic Systems	Men	Freq	T/K	M/S	IND
1. Identify various types of hydraulic systems.					
2. Identify various types of pneumatic systems.					
3. Identify hydraulic fluids.					
4. Fabricate aluminum lines.					
5. Fabricate stainless lines.					
6. Install fittings and lines.					
7. Operate and service hydraulic system and components.					
8. Operate and service pneumatic system and components.					
9. Inspect and repair hydraulic system and components.					
10. Inspect and repair pneumatic system and components.					

Figure 2. MODIFIED QUESTIONNAIRE

Hydraulic and Pneumatic Systems	Men	Freq	T/K	M/S	IND
1. Identify various types of hydraulic systems.			3	1	3
2. Identify various types of pneumatic systems.			3	1	3
3. Identify hydraulic fluids.			3	1	3
4. Fabricate aluminum lines.			3	3	3
5. Fabricate stainless lines.			3	3	3
6. Install fittings and lines.			3	3	3
7. Operate and service hydraulic system and components.			3	1	3
8. Operate and service pneumatic system and components.			4	5	4
9. Inspect and repair hydraulic system and components.			3	1	3
10. Inspect and repair pneumatic system and components.			3	5	3

Figure 1 displays a small section of the original survey questionnaire. Those individuals who completed this questionnaire during the resurvey in 1969-1970 were not informed of the data results collected during the 1965-1966 survey. Figure 2 is an example of the modified questionnaire. The only difference between the two questionnaires is that the modified questionnaire displayed the data findings from the original 1966 survey for each particular task. These data findings, coded numbers 1 through 5, were enclosed in boxes under the T/K, M/S, and IND columns. These numbers were shown in an attempt to detect if a respondent knowing previous data results would answer differently from a respondent having no knowledge of the previous data.

The individuals receiving the modified questionnaire were requested to review the tasks and if the number given still reflected the level of technical knowledge, the conditions for manipulative skill, or the degree of industry training, they were to insert the same number in the appropriate column. If the indicated number was not applicable, they were to indicate the number which now relates to their particular job requirements. Blank spaces were provided on both questionnaires at the conclusion of each topic so that tasks that were not identified in the 1966 survey could be inserted and considered in the review of the data. Respondents to both questionnaires were required to complete the Men and Freq (frequency) columns.

Both survey questionnaires had five columns requiring a response for each of 508 tasks to be considered in determining job requirements: column 1, the number of men performing the task; column 2, the frequency with which the task is performed; column 3, the technical knowledge required to accomplish the task; column 4, the conditions under which manipulative skill is used to accomplish the task; and column 5, the degree of training offered in the industry.

Data was collected during the resurvey for 10,916 of the mechanics employed in the companies studied. This resurvey of 30 percent of the original companies studied in 1966 represents 63.2 percent of the mechanics originally surveyed. This number was more than sufficient to enable a reliable comparative analysis of the two survey instruments to be made.

INTERPRETATION OF SURVEY RESULTS

On the following pages are the tables presenting all of the data collected by the resurvey. Each table has a major topic heading and shows the subtopics performed by the aviation mechanic. The subtopics are arranged in descending order from most frequent to least frequent, as determined by the percent of mechanics performing that task.

KEY TO TABLES

Data is presented in six columns with the headings identified as N, F, T, M, I, and $\overset{A}{R}$ as shown in the example below.

	N	F	T	M	I	$\overset{A}{R}$

The headings represent the following:

N - Percent of mechanics performing the task

F - Frequency with which the task is performed

T - Technical knowledge required to perform the task

M - Manipulative skill required to perform the task

I - Industry training offered

$\overset{A}{R}$ - National Advisory Committee recommendations for T/K level

Each of the first five columns is divided in accordance with the four industrial categories, identified by A, O, L, and S, as shown in the example below.

	N	F	T	M	I	A R
	A O L S	A O L S	A O L S	A O L S	A O L S	

These headings represent the following:

A - Airline line stations

O - Airline overhaul stations

L - Large general aviation companies

S - Small general aviation companies

Data applicable to the N column is represented by the following symbols which indicate the percentage of mechanics performing each task:

— - Tasks performed by less than 2 percent of the mechanics in that industrial category

$ - Tasks performed by 2 to 5 percent of the mechanics in that industrial category

+ - Tasks performed by 5 to 10 percent of the mechanics in that industrial category

1-9 - Tasks performed by 10 to 99 percent of the mechanics in that industrial category (1 = 10 to 19 percent of the mechanics; 2 = 20 to 29 percent of the mechanics; 3 = 30 to 39 percent of the mechanics, etc.).

	N	F	T	M	I	A R
	A O L S	A O L S	A O L S	A O L S	A O L S	
	$ - + 1					

Data applicable to the F column is represented by the following letters which indicate the frequency with which the task is performed:

L The job is performed semi-annually or less often (low frequency)

M The job is performed monthly (medium frequency)

H The job is performed daily or weekly (high frequency)

No Letter - The task is not performed.

	N	F	T	M	I	A R
	A O L S	A O L S	A O L S	A O L S	A O L S	
	$ - + 1	H H L H				

Data applicable to the T column is represented by the following numbers which indicate the technical knowledge required to perform a given task:

1 - Knowledge (knowledge of where information is to be found and the ability to follow directions)
2 - Comprehension (ability to interpret information and drawings needed in performing a job)
3 - Application (knowledge and understanding of principles and processes and the ability to apply them to specific situations)
4 - Analysis (ability to break down a malfunction into its fundamental parts in order to trouble-shoot)
5 - Synthesis (ability to put together knowledge of principles and procedures to complete repairs including the construction of new or substitute parts)

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
	$ - + 1	H H L H	3 3 3 3			

Data applicable to the M column is represented by the following numbers which indicate the conditions under which manipulative skill is required by the task:

1 - Not needed
2 - Reasonable time limit, no job planning required
3 - Reasonable time limit, job planning required
4 - Time critical, no job planning required
5 - Time critical, job planning required

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
	$ - + 1	H H L H	3 3 3 3	3 4 3 3		

Data applicable to the I column is represented by the following numbers which indicate the degree of training offered by industry:

1 - No training offered
2 - Orientation or familiarization training offered
3 - Basic or general information training offered
4 - Training in depth offered

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
	$	-	+	1	H	H	L	H	3	3	3	3	3	4	3	3	3	4	2	3	

Beginning with Table 44, the M column is replaced by the A/S column, as in the example below. The applicable A/S data is represented by the following numbers which indicate whether accuracy or accuracy and speed are required in performing each task:

1 - The task must be performed with accuracy

2 - The task has to be done with accuracy and speed

(Note: Table 52, Ethics and Legal Responsibilities, does not have an M or A/S column because neither of these factors is applicable to the topic.)

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
	$	-	+	1	H	H	L	H	3	3	3	3	1	2	1	1	3	3	2	3	

Data displayed in the $\overset{A}{R}$ column represents the technical knowledge level recommended by the National Advisory Committee for that task. The definition of levels for the $\overset{A}{R}$ column is the same as the definition given above for the T column.

	N				F				T				M/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
	$	-	+	1	H	H	L	H	3	3	3	3	1	2	1	1	3	3	2	3	3

Note: When a blank appears in all six columns in any one industrial category, it means the task is not performed by that industrial category.

TABLE 1. WOODWORK

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
MAKE RIB REPAIR			$	2			L	L			1	2			2	3			1	1	1
USE GLUES AND CLAMPS	-	-	$	2	H	H	H	L	3	3	3	3	3	3	1	3	3	3	3	3	3
IDENTIFY WOOD DEFECTS			$	2			L	L			1	3			1	3			3	3	3
BUILD A RIB			$	1			L	L			1	3			3	3			1	1	1
BUILD WING SECTION			$	1			L	L			1	3			2	3			1	1	1
MAKE SPAR SPLICE			$	1			L	L			1	3			3	3			1	1	1
USE NACA AIRFOIL SPECIFICATIONS			-	+			L	L			3	3			3	3			1	1	1
CONSTRUCT JIGS	-	-	-	2	H	M	L	L	3	3	1	3	2	4	3	3	1	4	3	3	2
SELECT MATERIALS	-	-	$	2	L	H	L	L	3	3	1	3	3	3	3	3	3	1	3	3	2
HANDLE AND STORE WOOD	-	-	-	1	H	L	L	L	3	1	1	3	2	1	3	3	3	1	3	3	1
TEST STRENGTH OF SPLICES			-	1			L	L			1	3			3	3			3	3	2
MAKE APPROVED SPLICES			$	2			L	L			1	3			3	3			3	3	1
REPAIR OF INTERIOR WOODWORK*		-	-	1		H	H	L		3	1	3		3	3	3		3	3	3	1

TABLE 2. FABRIC COVERING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INSPECT AND REPAIR STRUCTURE FOR COVER	-		+	3	L		L	M	2		3	3	2		3	3	2		3	3	3
SELECT MATERIALS	-		$	3	L		L	M	3		3	3	3		3	3	3		3	3	1
PERFORM HAND SEWING	-		$	3	L		L	L	3		3	3	3		3	3	1		3	3	2
COVER WING, STRUCTURE, OR CONTROL SURFACE	-		$	3	L		L	L	3		3	3	3		3	3	3		3	1	2
REPAIR FABRIC	-	-	+	4	L	L	L	M	2	3	3	3	3	3	3	3	3	4	3	3	2
PERFORM FABRIC PROTECTION AND TESTING	-	-	+	3	L	L	M	M	3	3	3	3	3	3	2	3	3	4	3	3	3
PERFORM POWER SEWING	-		-	2	H		L	L	2		3	3	3		3	3	2		3	2	2

TABLE 3. PAINTING AND FINISHING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
PREPARE SURFACE AND PRIME	$	+	+	6	H	H	H	M	2	3	3	3	2	3	3	3	3	4	3	3	2
BRUSH PAINTING	+	-	$	3	H	H	H	M	2	2	3	3	3	3	2	3	2	3	3	3	2
SPRAY PAINTING	$	+	+	5	M	H	H	M	3	3	3	3	3	3	3	3	2	3	3	3	2
LAYOUT LETTERS AND MASK	-	+	+	5	M	H	H	M	3	3	3	3	3	3	3	3	2	4	3	3	1
LAYOUT TRIM DESIGNS	$	$	$	4	M	H	M	L	3	3	3	3	3	3	3	3	3	3	3	3	1
INSPECT AND IDENTIFY DEFECTS	$	+	+	6	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	3
TOUCH-UP PAINTING	1	1	1	6	H	H	H	H	3	3	3	3	2	3	2		3	3	3	3	2
APPLY DOPE	-		$	5	M		L	M	3		3	3	3		3	3	3		3	3	2

TABLE 4. SHEET METAL

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
INSTALL CONVENTIONAL RIVETS	4 2 2 8	H H H M	2 3 3 3	3 3 3 3	3 4 3 3	3
DIMPLE METAL	+ 2 1 7	M H H M	3 3 3 3	3 3 3 3	3 4 3 3	3
INSTALL SPECIAL RIVETS	2 2 1 6	H H H H	3 3 3 3	4 3 3 3	3 4 3 3	3
INSTALL SPECIAL FASTENERS	2 2 1 6	H H H M	3 3 3 3	4 3 3 3	3 4 3 3	2
MAKE PATCHES	3 2 2 8	H H H M	3 3 3 3	4 3 3 3	3 4 3 3	3
MAINTAIN AERODYNAMIC SMOOTHNESS	3 2 1 5	H H H M	3 3 3 3	3 3 3 3	3 3 3 3	2
FABRICATE FROM TEMPLATE	+ 1 + 5	M H M L	3 3 3 3	3 3 3 3	4 4 3 3	2
HAND FORMING	+ + 1 5	M H M L	3 3 3 3	3 3 3 3	3 3 3 3	3
PROTECT METAL FROM DAMAGE	3 2 2 6	H H H M	3 3 3 3	3 3 2 3	3 4 2 3	2
USE BEND ALLOWANCE	1 1 1 5	H H H L	3 3 3 3	3 3 3 3	3 4 3 3	3
IDENTIFY AND CONTROL CORROSION	3 2 2 7	H H H H	3 3 3 3	4 3 3 3	3 3 3 3	3
REPAIR STRUCTURE	2 2 2 7	H H H M	3 3 3 3	4 3 3 3	3 4 3 3	3
USE ADHESIVE METAL BONDING	2 2 + 2	H H H M	3 3 3 3	4 3 3 3	3 4 3 3	3
DEVELOP TEMPLATE FROM BLUEPRINT	+ 1 + 5	M H M L	3 3 3 3	3 3 3 3	3 4 3 3	2
INSPECT AND REPAIR PLASTICS AND FIBERGLASS	2 + 1 6	H H H M	3 3 3 3	4 3 3 3	3 4 3 3	3
SHAPE METAL I.E. HOT WORKING, COLD WORKING, CASTING, CHEMICAL MILLING, ETC.	$ 1 $ 2	H H H L	3 3 3 3	3 3 3 3	3 3 3 3	1
REPAIR HONEYCOMB AND LAMINATED STRUCTURE	2 1 + 2	H H H M	3 3 3 3	4 3 3 3	3 4 3 3	2

NOTE: PROTECT METAL FROM DAMAGE-THEORY ONLY

TABLE 5. WELDING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
SOLDER	1	2	1	6	H	H	H	M	3	3	3	3	2	3	3	3	3	3	3	1	2
IDENTIFY TYPES OF WELDED JOINTS	+	+	1	5	L	H	M	M	1	2	3	3	3	3	3	3	2	3	2	3	1
WELD STAINLESS STEEL	-	+	$	3	H	H	H	M	3	2	3	3	3	3	3	3	4	3	1	1	2
ARC WELDING	$	+	$	2	M	H	M	L	3	2	3	3	3	3	3	3	3	4	1	1	2
SOLDER STAINLESS STEEL	$	1	$	1	M	H	L	L	3	3	3	3	3	3	3	3	3	3	3	1	2
FABRICATE TUBULAR STRUCTURES	-	$	$	3	H	H	L	L	3	3	3	3	3	3	3	3	3	3	3	3	2
CONTROL ALIGNMENT WHILE WELDING	$	+	$	3	H	H	L	L	3	2	3	3	3	3	3	3	3	3	2	1	2
INSPECT AND TEST WELDS	-	$	$	4	H	H	H	M	3	2	3	2	2	3	3	3	4	3	3	1	3
WELD STEEL (GAS)	$	+	$	5	M	H	M	M	3	3	3	3	3	3	3	3	3	3	2	3	2
WELD ALUMINUM	-	+	$	2	M	H	H	M	3	2	3	3	3	3	3	3	4	3	1	1	2
BRAZE	+	+	+	1	H	H	H	M	3	2	3	3	3	3	3	3	3	3	2	1	2
TANK REPAIR	-	$	-	2	M	H	M	L	3	3	3	3	3	3	3	3	1	3	3	1	1
WELD MAGNESIUM	-	$	-		M	H	M		3	3	3		3	3	3		3	4	1		1
WELD TITANIUM	-	$	-		H	H	H		3	3	3		3	3	3		4	3	1		1

TABLE 6. ASSEMBLY AND RIGGING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
USE MANUFACTURER'S AND FAA SPECIFICATIONS	4	1	3	8	H	H	H	H	2	3	3	3	4	3	3	3	3	3	3	3	3
RIG MOVABLE SURFACES	+	+	2	7	H	H	H	H	3	3	3	3	4	3	3	3	4	4	3	3	3
RIG FIXED SURFACES	+	$	2	7	L	H	H	M	2	3	3	3	3	3	3	3	4	4	3	3	3
RIG AIRCRAFT	2	+	2	6	M	H	H	M	3	3	3	3	3	3	3	3	4	4	3	3	2
USE TRANSIT	-	-	+	3	L	H	M	L	3	3	3	3	3	3	3	3	1	3	1	1	1
TRAM AND ALIGN STRUCTURE	$	$	+	5	L	H	M	L	2	3	3	3	3	3	3	3	3	3	3	3	3
BALANCE CONTROL SURFACES	2	-	1	5	L	H	H	M	2	3	3	3	3	3	3	3	3	3	3	3	3

TABLE 7. LANDING GEAR

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
SERVICE AND REPAIR																					
LANDING GEAR	6	1	2	9	H	H	H	H	3	3	3	3	4	3	2	3	3	4	3	3	3
INSPECT AND REPLACE TIRES AND WHEELS	6	1	2	9	H	H	H	H	3	3	3	3	3	4	2	3	3	4	2	3	3
SERVICE AND REPAIR																					
LEVELING DEVICES	4	+	1	1	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3	2
SHOCK STRUTS	6	1	2	6	H	H	H	H	3	3	3	3	4	4	3	3	3	4	2	2	2
NOSE WHEEL STEERING	5	+	2	8	H	H	H	H	3	3	3	3	4	3	2	3	3	4	4	3	2
BRAKES	6	1	2	9	H	H	H	H	3	4	3	3	3	4	2	3	3	4	2	3	3
JACK AIRCRAFT AND TEST GEAR	5	+	2	8	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3	3
INSPECT DAMAGE AND WEAR TO LIMITS	4	1	2	8	H	H	H	H	3	4	3	3	3	4	3	3	3	3	3	3	3
CHECK ALIGNMENT	2	+	2	7	H	H	H	H	2	4	3	3	3	3	3	3	3	4	3	3	3
SERVICE AND REPAIR																					
ANTI-SKID DEVICES	4	+	1	4	H	H	H	H	4	4	3	3	3	3	3	3	3	4	2	3	1

TABLE 8. HYDRAULIC AND PNEUMATIC SYSTEMS

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
OPERATE AND SERVICE HYDRAULIC SYSTEM AND COMPONENTS	6 2 2 8	H H H H	3 3 3 3	3 3 3 3	3 3 3 3	3
OPERATE AND SERVICE PNEUMATIC SYSTEM AND COMPONENTS	5 1 1 6	H H H H	3 3 3 3	3 4 2 3	3 4 3 3	3
IDENTIFY VARIOUS TYPES OF HYDRAULIC SYSTEMS	5 1 3 6	H H H H	3 3 3 3	3 3 3 3	3 3 2 3	2
IDENTIFY VARIOUS TYPES OF PNEUMATIC SYSTEMS	5 1 2 5	H H H H	3 3 3 3	3 3 2 3	3 3 3 3	2
IDENTIFY HYDRAULIC FLUIDS	6 2 3 8	H H H H	3 3 3 3	3 2 2 3	3 3 2 3	3
INSTALL FITTINGS AND LINES	6 1 2 8	H H H M	3 3 3 3	3 4 2 3	3 3 3 3	3
INSPECT AND REPAIR HYDRAULIC SYSTEM AND COMPONENTS	6 1 2 8	H H H H	3 4 3 3	3 4 3 3	3 3 2 3	2
INSPECT AND REPAIR PNEUMATIC SYSTEM AND COMPONENTS	5 1 2 5	H H H H	3 4 3 3	3 3 3 3	3 4 3 3	2
FABRICATE ALUMINUM LINES	3 $ 1 7	H H M M	3 3 3 3	2 2 3 3	3 3 3 3	3
FABRICATE STAINLESS LINES	3 $ 1 4	M H H M	3 3 3 3	3 2 3 3	3 3 3 3	2

TABLE 9. FUEL SYSTEM

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
IDENTIFY FUEL SYSTEMS	5 1 3 7	H H H H	3 3 3 3	2 2 3 3	3 3 2 3	1
CHECK AND SERVICE FUEL SYSTEMS AND COMPONENTS	7 1 3 8	H H H H	3 3 3 3	3 3 2 3	3 4 3 3	3
IDENTIFY FUELS	5 1 2 8	H H H H	3 2 2 3	2 2 2 2	3 2 3 3	3
SERVICE FUEL DUMP SYSTEMS	4 1 + 2	H H H L	3 3 3 3	3 3 2 3	3 4 3 3	1
FABRICATE AND REPLACE LINES AND FITTINGS	3 1 2 8	H H H H	3 3 3 3	3 3 3 3	3 4 3 3	3
INSPECT AND REPAIR FUEL SYSTEM COMPONENTS	4 1 3 8	H H H H	3 4 3 3	3 4 3 3	3 4 3 3	3
REPAIR AND SEAL FUEL TANKS	3 2 1 6	L H M L	2 3 3 3	3 3 3 3	3 4 3 3	2

TABLE 10. AIR CONDITIONING AND PRESSURIZATION

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
CHECK AND SERVICE PNEUMATICS AND HEAT EXCHANGERS	4	1	1	3	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	3	2
INSPECT, REPLACE OR REPAIR																					
PNEUMATIC SYSTEM COMPONENTS	5	1	2	4	H	H	M	M	3	3	3	3	3	4	3	3	3	4	3	3	1
AIR CONDITIONING SYSTEM COMPONENTS	4	1	2	3	H	H	M	M	3	3	3	3	3	3	3	3	3	4	3	4	1
CHECK AND SERVICE HEAT AND COOLING SYSTEMS AND THEIR CONTROL SYSTEMS	5	+	1	5	H	H	H	M	3	3	3	3	3	3	2	3	3	4	4	3	2
CHECK AND SERVICE OXYGEN SYSTEMS	6	1	2	6	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	2
CHECK AND SERVICE AIRCRAFT PRESSURIZATION AND CONTROL SYSTEMS	3	+	1	2	H	H	H	M	3	3	3	3	3	3	2	3	3	4	4	2	2
INSPECT, REPLACE OR REPAIR																					
PRESSURIZATION SYSTEM COMPONENTS	4	1	2	2	H	H	M	M	3	3	3	3	3	4	3	3	3	4	3	3	2
OXYGEN SYSTEMS AND COMPONENTS	5	1	3	5	H	H	M	M	3	3	3	3	3	4	3	3	3	4	3	3	2
TROUBLESHOOT AND REPAIR AIR CONDITIONING AND PRESSURIZATION SYSTEMS	2	1	1	3	H	H	H	M	4	4	4	4	4	4	3	3	4	4	3	3	2

TABLE 11. ELECTRICAL POWER

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY ELECTRON THEORY AND FUNDAMENTALS OF ELECTROMAGNETISM																					
IN READING AND ANALYZING DC AND AC CIRCUITS AND DIAGRAMS	2	1	1	6	H	H	H	H	4	4	3	3	3	3	3	3	3	4	3	3	2
IN OPERATION AND TESTING OF DC AND AC ELECTRICAL COMPONENTS	2	1	1	6	H	H	H	H	4	4	3	3	3	3	3	3	3	4	3	3	2
APPLY ELECTRICAL MEASURING AND INDICATING DEVICES FOR																					
MEASUREMENT OF VOLTAGE, CURRENT, AND RESISTANCE	2	2	1	7	H	H	H	H	3	3	3	3	3	3	2	2	3	3	3	3	3
CHECKING OF CONTINUITY AND ELECTRICAL LEAKAGE	2	2	1	7	H	H	H	H	3	3	3	3	3	2	3	3	3	3	3	3	3
PROMOTE AND PRACTICE ELECTRICAL SAFETY AND HAZARD PRECAUTIONS	5	3	2	7	H	H	H	H	3	1	3	3	3	1	3	2	4	3	3	3	3
APPLY ELECTRON THEORY AND FUNDAMENTALS OF ELECTROMAGNETISM																					
IN TROUBLESHOOTING AIRCRAFT WIRING AND ELECTRICAL INSTALLATIONS	2	+	1	6	H	H	H	H	3	4	4	3	3	3	3	3	3	4	3	3	3
APPLY ELECTRICAL MEASURING AND INDICATING DEVICES FOR																					
CALCULATION OF RESISTANCE AND CONDUCTIVITY	1	1	1	4	H	H	H	M	3	3	3	3	2	2	3	3	4	3	3	3	3
CHECKING AND MEASURING CAPACITANCE	1	1	+	4	H	H	H	M	3	3	3	3	3	3	3	3	3	3	3	3	3
CHECKING AND MEASURING INDUCTANCE	1	+	+	3	H	H	H	M	3	3	3	3	3	3	3	3	3	3	3	3	1

TABLE 11. ELECTRICAL POWER (CONTINUED)

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
TROUBLESHOOT AND REPLACE DC AND AC MOTORS AND CONTROL UNITS	2	2	1	6	H	H	H	M	3	2	4	3	3	3	3	3	3	3	3	3	3
CHECK AND REPLACE RELAYS, SOLENOIDS, SWITCHES AND RHEOSTATS	2	2	1	7	H	H	H	H	3	2	3	3	3	3	3	3	3	3	3	3	3
CHECK AND REPLACE TRANSFORMERS, RECTIFIERS AND FILTERS	1	1	+	4	H	H	H	H	3	2	3	3	3	2	3	3	3	3	3	1	2
CHECK AND REPLACE ELECTRICAL PROTECTIVE DEVICES	2	1	1	6	H	H	H	H	3	3	3	3	3	2	3	3	3	3	3	3	2
APPLY ELECTRON THEORY AND FUNDAMENTALS OF ELECTROMAGNETISM																					
IN TROUBLESHOOTING AIRCRAFT AC POWER SYSTEMS	2	+	+	3	H	H	H	H	4	4	4	4	3	4	3	3	4	4	3	3	2
IN TROUBLESHOOTING AIRCRAFT DC POWER SYSTEMS	2	+	1	6	H	H	H	H	4	4	4	4	3	4	3	3	4	4	3	3	2
APPLY ELECTRICAL MEASURING AND INDICATING DEVICES FOR																					
MEASUREMENT AND CALCULATION OF POWER	1	1	1	3	H	H	H	M	3	3	3	3	3	2	3	2	3	3	3	1	2
CHECKING AND TESTING THERMOCOUPLES	1	+	1	5	H	H	H	M	3	3	3	3	2	3	3	3	3	3	3	2	2
TROUBLESHOOT AND REPLACE DC AND AC GENERATOR EQUIPMENT	3	1	1	6	H	H	H	M	4	4	4	3	3	4	3	3	3	3	3	3	3
INSTALL AND REPAIR ELECTRICAL WIRING AND DISTRIBUTION EQUIPMENT	2	1	1	6	H	H	H	H	2	3	3	3	3	3	3	3	3	3	3	3	3
TEST AND REPAIR AIRCRAFT GENERATOR AND INVERTER CONTROL SYSTEMS	1	+	+	5	H	H	H	M	3	4	3	3	3	4	3	3	3	4	3	3	1

TABLE 11. ELECTRICAL POWER (CONTINUED--2)

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY BATTERY THEORY AND TEST EQUIPMENT																					
TO MAINTAIN AND TEST LEAD ACID BATTERIES	1	-	1	6	H	H	H	H	3	3	3	3	2	3	2	3	3	3	2	2	2
TO TEST AND MAINTAIN EDISON CELLS AND NICKEL CADMIUM BATTERIES	1	$	+	4	H	H	H	M	3	3	3	3	3	2	2	3	3	3	3	3	2
TO OPERATE AND MAINTAIN BATTERY CHARGERS	1	-	1	7	M	H	H	H	3	3	3	3	3	3	2	3	3	3	3	2	2
CHECK AND TROUBLESHOOT SOLID STATE INVERTERS	1	+	+	3	H	H	H	M	3	4	4	3	3	3	3	3	3	4	3	3	1
INSPECT, TEST AND REPAIR AIRCRAFT MOTORS, GENERATORS AND INVERTERS	+	+	1	6	H	H	H	H	3	4	3	3	3	3	3	3	3	3	3	3	2
APPLY BATTERY THEORY AND TEST EQUIPMENT																					
TO TEST AND SERVICE DRY BATTERY EQUIPMENT	+	-	+	4	H	H	H	M	3	2	3	3	3	2	3	2	3	3	3	3	1
CHECK AND TROUBLESHOOT SOLID STATE SWITCHING DEVICES	1	+	+	3	H	H	H	M	4	4	4	3	3	3	3	3	3	4	3	3	2
TEST AND REPAIR SOLID STATE INVERTERS AND SWITCHING DEVICES	+	+	$	2	H	H	H	M	3	4	3	3	3	3	3	3	3	4	3	3	1

TABLE 12. FLIGHT INSTRUMENTS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
TROUBLESHOOT AND MAINTAIN																					
MAGNETIC COMPASSES AND HEADING INDICATORS	1	+	1	4	H	H	H	H	3	3	3	3	3	3	3	3	4	4	3	3	2
AIRSPEED INDICATORS AND MACHMETERS	1	+	1	4	H	H	H	M	3	3	4	3	4	3	3	3	4	4	3	3	2
ALTIMETERS, RATE OF CLIMB AND VERTICAL SPEED INDICATORS	1	+	1	3	H	H	H	M	3	3	3	3	3	3	3	3	4	4	3	3	2
CLOCKS AND ELAPSED TIME INDICATORS	1	+	1	3	H	H	H	M	3	3	4	3	2	3	3	3	4	3	3	3	1
TEMPERATURE AND PRESSURE INSTRUMENTS	1	1	1	3	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	2
TURN AND BANK, HORIZON, AND YAW INSTRUMENTS	1	+	1	3	H	H	H	M	3	3	3	3	3	3	3	3	4	4	3	3	2
FLAP AND CONTROL SURFACE POSITION INDICATORS	1	1	1	5	H	H	H	M	3	3	4	3	3	3	3	3	3	4	3	3	2
TROUBLESHOOT AND MAINTAIN																					
PITOT STATIC, RAM AIR AND VACUUM SYSTEMS	2	+	1	6	H	H	H	M	3	3	3	3	3	3	3	3	4	4	3	3	2
RESISTANCE AND THERMOCOUPLE INDICATOR SYSTEMS	1	+	1	5	H	H	H	M	3	3	3	3	3	4	3	3	4	4	3	3	2
SYNCHRO REMOTE INDICATION SYSTEM	1	+	+	3	H	H	H	M	3	4	4	3	3	3	2	3	4	4	3	3	2
TEST AND REPAIR																					
COMPASSES AND HEADING INDICATOR SYSTEMS	1	$	$	1	H	H	H	M	3	4	4	3	3	4	3	3	4	4	3	3	1
AIRSPEED, RATE OF CLIMB AND ALTITUDE INDICATOR SYSTEMS	1	$	+	1	H	H	H	M	3	4	4	3	3	4	3	3	4	4	3	3	2
TEMPERATURE AND PRESSURE INDICATION SYSTEMS	1	$	+	1	H	H	H	M	3	4	3	3	3	4	3	3	4	4	3	3	2

TABLE 12. FLIGHT INSTRUMENTS (CONTINUED)

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
TROUBLESHOOT AND MAINTAIN						
ELECTRONIC INDICATING AND COMPUTING SYSTEMS	1 + + 2	H H H M	3 4 4 3	3 3 3 3	4 4 3 1	1
INTEGRATED TYPE OF FLIGHT INSTRUMENTATION	1 + + 1	H H H M	3 4 4 3	3 4 4 3	4 4 3 3	1
TEST AND REPAIR						
ELECTRONIC COMPUTERS AND INTEGRATING SYSTEMS	+ $ $ 1	H H H L	3 3 4 3	3 4 4 3	4 4 4 2	1
SYNCHRO SYSTEMS AND MAGNETIC AMPLIFIERS	+ $ + 1	H H H L	3 4 3 3	3 3 3 3	3 4 3 3	1

TABLE 13. AUTO PILOTS AND APPROACH CONTROLS

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
OPERATE AND CHECK AUTO PILOT AND APPROACH CONTROL SYSTEMS	1 + + 2	H H H H	4 4 4 3	2 4 3 3	4 4 4 3	1
TROUBLESHOOT AND MAINTAIN						
FLIGHT CONTROL SERVO UNITS	1 $ + 2	H H H L	4 4 3 3	3 3 3 3	4 4 3 3	1
CHECK AND TROUBLESHOOT AUTO PILOT INTERLOCK SYSTEMS	1 + + 1	H H H M	4 3 4 3	2 4 3 3	4 4 4 3	1
TROUBLESHOOT AND REPLACE AUTO PILOT AND APPROACH CONTROL COMPUTERS AND AMPLIFIER UNITS	1 $ + 2	H H H M	4 4 4 3	2 4 3 3	4 4 4 3	1
TROUBLESHOOT AND MAINTAIN						
AUTO PILOT SIGNAL SOURCE UNITS	1 $ + +	H H H M	4 4 4 4	3 3 3 3	4 4 4 2	1
POWER SUPPLIES AND PHASE CONTROL	1 + $ 1	H H H M	4 4 4 4	3 3 3 3	4 4 4 2	1
INSPECT, TEST AND REPAIR						
AUTO PILOT CONTROL AND INTERLOCK SYSTEMS	+ $ + +	H H H M	4 3 3 3	4 3 3 3	4 4 3 3	D
TROUBLESHOOT AND MAINTAIN						
HORIZONTAL STABILIZER CONTROL AND MACH TRIM SYSTEMS	1 $ + 1	H H H L	4 4 4 4	3 2 3 3	4 4 3 3	1
YAW DAMPER SYSTEMS	1 $ $ 1	H H H L	4 4 4 4	4 3 3 3	4 4 4 2	1
AUTO APPROACH CONTROL	1 $ $ +	H H H L	4 4 4 4	3 3 3 3	4 4 4 2	1

TABLE 13. AUTO PILOTS AND APPROACH CONTROLS - CONTINUED

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INSPECT, TEST AND REPAIR																					
AUTO PILOT AND APPROACH CONTROL AMPLIFIERS, COMPUTERS AND COUPLERS	+	$	+	$	H	H	H	M	4	3	3	3	3	3	3	2	4	4	4	3	D
TROUBLESHOOT AND MAINTAIN																					
GLIDE PATH EXTENSION AND RELATED DATA COMPUTERS	1	$	$	+	H	H	H	L	4	4	4	4	3	3	3	3	4	4	4	2	1
INSPECT, TEST AND REPAIR																					
AUTO PILOT FLIGHT CONTROL SERVOS AND DRIVE MECHANISMS	+	$	+	+	H	H	H	M	3	3	3	3	3	3	3	3	4	4	4	3	D
AUTO PILOT SIGNAL SOURCE SYSTEMS AND UNITS	+	$	+	+	H	H	H	M	4	3	3	3	3	3	3	3	4	4	4	3	D

TABLE 14. AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INSPECT AND REPAIR																					
ANTENNA INSTALLATIONS	1	+	+	7	H	H	H	M	3	3	3	3	3	2	2	3	3	3	3	3	2
RADIO RACKS AND RELATED EQUIPMENT	2	+	+	5	H	H	H	M	3	3	3	3	4	2	2	3	3	3	2	3	3
RADIO AND ELECTRONIC WIRING, SWITCHING AND PROTECTIVE SYSTEMS	1	+	+	5	H	H	H	M	4	2	3	3	4	2	3	3	3	3	3	1	2
OPERATE AND CHECK AIRCRAFT HF AND VHF RADIO RECEIVERS AND TRANSMITTERS	1	$	$	3	H	H	H	H	3	3	3	3	4	3	2	3	3	4	3	1	2
CHECK, TROUBLESHOOT AND REPLACE																					
VHF RECEIVER AND TRANSMITTER SYSTEMS	1	$	$	2	H	H	H	M	4	4	3	3	4	4	2	3	4	4	3	1	1
HF RECEIVER AND TRANSMITTER SYSTEMS	+	$	$	1	H	H	H	M	4	4	3	3	4	4	2	3	4	4	3	1	1
CHECK AND REPLACE																					
GYRO AND RADIO COMPASS SYSTEMS	1	+	$	4	H	H	H	M	3	3	3	3	4	4	2	3	3	4	3	1	1
ADF AND VOR SYSTEMS	1	+	$	3	H	H	H	M	3	3	3	3	4	4	2	3	3	4	3	1	1
MARKER, LOCALIZER AND GLIDE SLOPE RECEIVERS	1	+	$	2	H	H	H	M	3	3	3	3	4	4	2	3	3	4	3	1	1
INSPECT AND REPAIR																					
CONTROL UNITS AND PANELS	1	+	+	4	H	H	H	L	4	3	3	3	4	3	2	3	3	3	3	1	1
HEADSETS, MICROPHONES AND SPEAKERS	+	1	+	4	H	H	H	M	3	3	3	3	4	3	2	3	3	3	3	1	1

TABLE 14. AIRCRAFT COMMUNICATIONS AND NAVIGATION EQUIPMENT - CONTINUED

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
CHECK AND REPLACE																					
DME AND DMET SYSTEMS AND OFF-COURSE COMPUTERS	1	$	$	2	H	H	H	M	3	3	3	3	4	4	2	3	3	4	3	2	1
WEATHER RADAR SYSTEMS	1	+	$	1	H	H	H	M	4	3	3	3	4	4	2	3	3	4	2	1	1
CHECK, TROUBLESHOOT AND REPLACE																					
FLIGHT COMPARTMENT INTERPHONE SYSTEMS	1	$	$	1	H	H	H	H	3	4	3	3	4	4	2	4	4	4	3	3	1
SERVICE AND PASSENGER COMPARTMENT INTERPHONE SYSTEMS	1	$	$	1	H	H	H	M	3	3	3	3	4	3	3	3	4	3	3	1	1
CHECK AND REPLACE																					
SELCAL AND TRANSPONDER SYSTEMS	1	+	$	1	H	H	H	L	4	3	3	3	4	4	2	3	4	4	3	1	1
CHECK, TROUBLESHOOT AND REPLACE																					
PASSENGER ANNOUNCEMENT AND ENTERTAINMENT SYSTEMS	1	+	$	2	H	H	H	M	3	3	3	3	4	4	3	3	3	4	3	1	1
CHECK AND REPLACE																					
FLIGHT DIRECTORS, DATA COMPUTERS AND INTEGRATING SYSTEMS	1	+	$	1	H	H	H	M	4	3	3	3	4	4	2	3	3	4	3	1	1
LORAN, DOPPLER RADAR, RADAR ALTIMETERS	1	+	-	1	H	H	H	M	3	4	3	3	4	3	2	3	4	4	3	3	D
RADIO ALTIMETERS AND TERRAIN CLEARANCE INDICATION SYSTEMS	1	+	$	1	H	H	H	M	3	3	3	3	4	3	4	3	4	4	3	3	1
FLIGHT RECORDERS	2	+	-	$	H	H	H	M	3	3	3	3	4	3	3	2	3	4	2	3	1

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TABLE 15. ENGINE INSTRUMENTS - ELECTRICAL

	N				F				T				M				I				A R
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	
INSPECT, TEST AND REPAIR																					
ELECTRICAL CONNECTIONS AND WIRING	1	+	1	6	H	H	H	H	3	4	3	3	2	3	3	3	3	3	3	3	3
INSTRUMENT PANELS AND UNIT MOUNTINGS	1	+	1	6	H	H	H	H	3	3	3	3	2	3	3	3	3	3	3	3	3
TROUBLESHOOT AND REPLACE																					
PRESSURE INDICATION SYSTEMS	2	1	1	6	H	H	H	M	3	3	3	3	2	4	3	3	3	4	3	1	3
TEMPERATURE INDICATION SYSTEMS	2	1	1	6	H	H	H	M	3	3	3	3	2	4	3	3	3	3	3	1	3
TACHOMETERS AND RPM INDICATORS	3	1	1	6	H	H	H	M	3	3	4	3	2	4	3	3	3	4	3	3	3
INSPECT, TEST AND REPAIR																					
ENGINE INDICATING SYSTEM COMPONENTS	1	$	1	4	H	H	H	H	3	4	3	3	3	3	3	3	4	3	3	3	1
TROUBLESHOOT AND REPLACE																					
RATE OF FLOW INDICATION SYSTEMS	2	1	1	5	H	H	H	M	2	3	3	3	2	3	3	3	3	4	2	3	2

TABLE 16. AIRCRAFT FUEL AND OIL MEASUREMENT AND CONTROL

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
PERFORM FUEL MANAGEMENT, TRANSFER AND DEFUELING	4	1	+	4	H	H	H	M	3	3	3	3	3	3	2	3	3	4	3	3	2
TROUBLESHOOT AND REPLACE																					
FUEL AND OIL ELECTRIC PUMPS, VALVES AND THEIR CONTROLS	3	2	2	7	H	H	H	M	3	4	3	3	4	4	3	3	3	3	3	3	2
FLUID QUANTITY INDICATION SYSTEMS	1	+	1	6	H	H	H	M	3	4	3	3	3	3	3	3	4	4	3	3	3
FLUID PRESSURE AND TEMPERATURE INDICATION SYSTEMS	3	1	1	6	H	H	H	M	3	3	3	3	2	3	3	3	3	3	3	3	3
FLUID SYSTEM WARNING DEVICES	3	1	1	5	H	H	H	M	3	3	3	3	2	4	3	3	3	4	3	3	2
CALIBRATE AND TEST																					
CAPACITANCE FUEL AND OIL QUANTITY INDICATION SYSTEMS	1	+	1	4	H	H	H	M	3	4	3	3	3	3	3	3	4	4	3	3	1
FLOAT TYPE FUEL AND OIL QUANTITY INDICATION SYSTEMS	1	+	1	4	H	H	H	M	3	3	3	3	3	3	3	3	3	3	3	3	1
INSPECT AND REPAIR																					
FUEL AND OIL PUMPS, VALVES AND OTHER CONTROL UNITS	2	$	1	5	H	H	H	M	3	3	3	3	4	3	3	3	4	3	3	3	1
FLUID QUANTITY INDICATION EQUIPMENT	1	$	1	5	H	H	H	M	3	4	3	3	2	3	3	3	4	4	2	3	1
PRESSURE AND TEMPERATURE INDICATION AND WARNING SYSTEMS	1	$	1	5	H	H	H	M	3	3	3	3	2	3	3	3	3	3	2	3	2
TROUBLESHOOT AND REPLACE																					
PRESSURE REFUELING CONTROL EQUIPMENT	7	1	1	3	H	H	H	M	3	3	3	3	3	4	3	3	3	3	3	3	1

TABLE 17. AIRCRAFT LANDING GEAR ELECTRICAL UNITS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
TROUBLESHOOT LANDING GEAR POSITION INDICATION AND WARNING SYSTEMS	2	+	2	7	H	H	H	M	3	3	3	3	3	4	3	3	3	4	2	3	2
CHECK AND TROUBLESHOOT GROUND-FLIGHT CHANGE OVER SWITCHES AND RELAYS	1	+	1	5	H	H	H	M	3	3	4	3	2	4	3	3	3	4	3	3	1
CHECK TAKEOFF WARNING SYSTEMS	2	+	1	4	H	H	H	H	3	3	3	3	2	4	3	3	3	4	3	3	1
INSPECT, TEST AND REPLACE																					
SPEED WARNING COMPONENTS	1	+	1	3	H	H	H	M	3	3	3	3	2	3	3	3	3	4	3	3	1
TAKEOFF WARNING COMPONENTS	1	+	1	3	H	H	H	M	3	3	3	3	2	3	3	3	3	4	3	3	1
LANDING GEAR AND GEAR DOOR SWITCHES	2	+	2	6	H	H	H	M	3	3	3	3	2	3	3	3	3	4	3	3	2
GROUND FLIGHT SWITCHES AND RELAYS	1	+	1	4	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	1	1
CHECK AND TROUBLESHOOT ELECTRICAL BRAKE CONTROLS AND ANTI-SKID CONTROL SYSTEMS	2	+	1	3	H	H	H	M	3	4	3	3	2	4	3	3	3	4	3	3	1
INSPECT, TEST AND REPLACE																					
ANTI-SKID CONTROL COMPONENTS	2	+	1	2	H	H	H	M	3	3	3	3	2	3	3	3	3	4	3	3	1

TABLE 18. FIRE DETECTION AND EXTINGUISHING SYSTEMS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
CHECK AND SERVICE																					
BIMETALIC, THERMOCOUPLE AND CONTINOUS STRIP FIRE DETECTION SYSTEMS	2	+	1	3	H	H	H	M	2	3	3	3	2	3	3	3	3	4	3	3	2
FIRE EXTINGUISHING SYSTEMS	5	1	1	4	H	H	H	M	1	3	3	3	2	4	3	3	3	4	3	1	2
INSPECT, REPLACE OR REPAIR																					
COMPARTMENT FIRE DETECTORS AND SYSTEM COMPONENTS	3	+	1	2	H	H	H	M	2	3	3	3	3	3	3	3	3	4	3	3	2
FIRE EXTINGUISHERS AND RELATED SYSTEM COMPONENTS	5	1	1	4	H	H	H	M	3	3	3	3	3	3	2	3	3	4	3	3	2
ENGINE AND NACELLE FIRE DETECTION COMPONENTS	3	+	1	3	H	H	H	M	2	3	3	3	2	3	3	3	3	4	2	3	2
CHECK AND SERVICE																					
SMOKE AND CARBON MONOXIDE DETECTION SYSTEMS	1	$	+	2	H	H	M	M	3	3	3	3	2	3	3	3	3	3	3	3	1
INSPECT, REPLACE OR REPAIR																					
SMOKE DETECTION COMPONENTS	1	+	+	2	M	H	H	M	3	3	3	3	3	3	3	3	2	3	3	3	D

TABLE 19. ICE AND RAIN CONTROL

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
CHECK AND SERVICE																					
POWERPLANT ICE CONTROL SYSTEMS	5	1	2	5	H	H	H	M	4	3	3	3	3	4	2	3	3	4	2	2	2
AIR SCOOPS AND LEADING EDGE ICE CONTROL SYSTEMS	5	1	1	5	H	H	M	M	4	3	3	3	4	4	3	3	3	4	2	2	2
ELECTRICAL WINDSHIELD ICE CONTROL SYSTEMS	2	+	1	4	H	H	H	M	3	3	3	3	3	4	3	3	3	4	3	2	1
INSPECT AND REPAIR																					
POWERPLANT ICE CONTROL COMPONENTS	3	$	1	5	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	1
CHECK AND SERVICE																					
ANTENNAS, ACCESSORIES, AND PITOT STATIC DEVICES	2	+	1	6	H	H	H	M	3	3	3	3	2	4	3	3	3	4	3	3	1
TROUBLESHOOT AND REPAIR WINDSHIELD RAIN REMOVAL AND WINDOW DEFOGGING SYSTEMS	2	1	1	3	H	H	H	M	4	3	4	3	4	2	3	3	4	4	3	3	1
INSPECT AND REPAIR																					
AIR SCOOP AND LEADING EDGE ICE CONTROL SYSTEMS	3	$	1	5	H	H	H	M	3	3	3	3	3	3	3	3	3	4	2	2	1
WINDSHIELD ICE CONTROL SYSTEMS	1	$	1	3	H	H	H	M	4	2	3	3	4	2	3	3	4	4	3	3	1
CHECK AND SERVICE																					
PNEUMATIC WINDSHIELD ANTI-ICING AND DEFOGGING SYSTEMS	1	$	1	4	H	H	M	M	3	3	3	3	3	3	2	3	3	4	2	2	1

TABLE 20. WARNING SYSTEMS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
CHECK AND SERVICE																					
HYDRAULIC POWER AND SYSTEM COMPONENTS	3	1	1	7	H	H	H	M	3	3	3	3	2	3	3	3	3	4	3	3	2
ICE AND RAIN PROTECTION	4	+	1	4	H	H	H	H	3	3	3	3	2	3	2	3	3	4	3	3	1
LIGHTS AND LIGHTING	3	+	2	7	H	H	H	M	3	3	3	3	2	3	2	3	3	4	3	3	2
DOORS AND EMERGENCY WINDOWS	4	+	1	5	H	H	H	M	3	3	3	3	2	3	3	2	3	4	3	3	2
FLIGHT CONTROLS, FLAPS, SPOILERS AND LEADING EDGE DEVICES	3	+	1	5	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	2
POWERPLANT STARTING AND VIBRATION	2	1	1	5	H	H	H	H	3	3	3	3	3	4	3	3	3	4	3	3	1
OVERSPEED AND UNDERSPEED	2	$	1	4	H	H	H	M	3	3	3	3	2	3	3	3	3	4	3	3	1
ELECTRICAL PNEUMATIC AND OXYGEN SYSTEMS	3	+	1	5	H	H	H	H	3	3	3	3	2	3	3	3	3	4	3	3	1
INSPECT AND REPAIR WARNING SYSTEM COMPONENTS	2	$	1	4	H	H	H	H	4	3	3	3	4	3	3	3	4	4	3	3	1

TABLE 21. RECIPROCATING ENGINES

	N	F	T	M	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
IDENTIFY TYPES AND PRINCIPLES OF RECIPROCATING POWERPLANTS	- + 3 8	L L H H	1 1 3 3	2 1 3 3	4 3 3 3	2
CHECK AND SERVICE						
FOURTEEN CYLINDER RADIAL ENGINE OR LARGER	- - 1 3	H L H M	2 3 3 3	2 3 3 3	2 3 3 3	1
INSPECT AND REPAIR						
FOURTEEN CYLINDER RADIAL ENGINE OR LARGER	- - 1 3	L L H M	3 4 3 3	2 3 3 3	4 3 3 3	1
REMOVE AND INSTALL ENGINE	- - 2 7	L L M M	3 3 3 3	3 3 3 3	3 4 3 3	3
CHECK AND SERVICE						
CYLINDER	- - 2 6	L L H H	3 4 3 3	2 3 3 3	4 3 3 3	3
INSPECT AND REPAIR						
CYLINDER	- - 2 6	H L H H	2 3 3 3	2 3 3 3	2 3 3 3	3
GEAR REDUCTION SECTION	- - 2 4	H L H M	2 3 3 3	2 3 3 3	2 3 3 3	2
SUPERCHARGER	- - 1 5	H L H M	2 3 4 3	2 3 3 3	2 3 3 3	2
TROUBLESHOOT	- - 2 9	M L H H	4 4 4 4	3 3 2 3	4 4 3 3	3
OPERATE ENGINE	- - 2 7	L L H H	3 4 3 3	3 4 3 3	4 4 3 3	3
INSPECT AND REPAIR						
FOUR OR SIX CYLINDER OPPOSED ENGINE	2 7	H H	3 3	3 3	3 3	3
SEVEN OR NINE CYLINDER RADIAL ENGINE	1 6	H M	4 3	3 3	3 3	3

TABLE 21. RECIPROCATING ENGINES (CONTINUED)

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
CHECK AND SERVICE																					
GEAR REDUCTION SECTION	-	-	1	4	L	L	M	M	3	4	3	3	3	3	3	3	4	3	3	3	3
SUPERCHARGER	-	-	1	4	L	L	H	M	3	4	3	3	3	3	3	3	4	3	3	3	3
FOUR OR SIX CYLINDER OPPOSED ENGINE			$	5			H	M			3	3			3	3			3	3	3
SEVEN OR NINE CYLINDER RADIAL ENGINE			$	1			L	M			3	3			3	3			3	3	3
OVERHAUL																					
FOUR OR SIX CYLINDER OPPOSED ENGINE			1	7			H	H			3	3			3	3			3	3	3
SEVEN OR NINE CYLINDER RADIAL ENGINE			1	5			H	M			3	3			3	3			3	3	2
CYLINDER		-	+	4		L	H	M		1	3	3		1	3	3		3	3	3	3
GEAR REDUCTION SECTION		-	$	2		L	M	M		1	3	3		1	3	3		3	3	3	2
SUPERCHARGER		-	$	1		L	M	L		1	3	3		1	3	3		3	3	3	2
FOURTEEN CYLINDER RADIAL ENGINE OR LARGER		-	-	+		L	H	M		1	3	3		1	3	3		3	3	3	1

TABLE 22. TURBINE ENGINES

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
IDENTIFY TYPES AND PRINCIPLES OF TURBINE ENGINES	4	+	3	2	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	1	2
REMOVE AND INSTALL ENGINE	4	2	2	2	M	H	H	L	3	3	3	3	5	5	3	3	4	3	3	3	2
INSPECT AND REPAIR																					
TURBOJET	4	+	3	2	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3	2
TURBOFAN	3	2	2	1	H	H	H	H	3	5	3	3	3	3	3	3	3	4	3	3	1
TURBOPROP		-	-			L	L			3	3			5	3			3	3		2
ACCESSORIES	3	1	2	2	H	H	H	M	3	4	3	3	4	3	3	3	3	4	3	3	3
CHECK AND SERVICE																					
TURBOJET	3	+	3	2	H	H	H	H	3	5	3	3	3	3	3	3	3	4	3	3	2
TURBOFAN	5	2	2	1	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	3	1
TURBOPROP	+	+	2	2	H	H	H	H	3	3	3	3	3	3	2	3	3	4	3	3	2
ACCESSORIES	6	1	2	2	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3	3
TROUBLESHOOT	4	1	1	2	H	H	H	M	4	4	3	3	4	4	2	3	4	4	3	3	2
OPERATE ENGINE	3	1	1	2	H	H	H	M	3	3	3	3	5	4	2	3	4	4	3	3	2
OVERHAUL																					
TURBOJET		-	$			H	H			5	3			3	3			4	3		2
TURBOFAN		+	+			H	H			3	3			5	3			3	3		1
TURBOPROP	+	+	3	2	H	H	H	H	3	5	3	3	4	3	3	3	3	4	3	3	2
ACCESSORIES	-	1	$	+	L	H	H	L	3	5	3	3	3	3	4	3	3	4	4	3	2

NOTE: IDENTIFY TYPES AND PRINCIPLES OF TURBINE ENGINES-THEORY ONLY

TABLE 23. LUBRICATING SYSTEMS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
IDENTIFY TYPES OF LUBRICATION SYSTEMS	4	1	3	6	H	H	H	H	2	2	2	3	3	4	2	3	3	3	3	3	2
IDENTIFY TYPES AND SPECIFICATIONS OF LUBRICANTS	4	1	3	6	H	H	H	H	2	2	2	3	2	3	2	3	3	3	3	3	2
CHECK AND SERVICE																					
COOLERS AND TEMPERATURE REGULATORS	4	$	3	6	H	H	H	M	2	3	3	3	3	4	2	3	3	4	2	3	2
PUMPS AND VALVES	4	$	3	6	H	H	H	M	2	3	3	3	3	4	2	3	3	4	2	3	2
SEALS AND OTHER COMPONENTS	5	$	3	7	H	H	H	M	2	3	3	3	3	3	2	3	3	3	3	3	2
TANKS AND LINES	6	$	3	6	H	H	H	M	2	3	3	3	3	3	2	3	3	3	3	3	2
INSPECT AND REPAIR																					
COOLERS AND TEMPERATURE REGULATORS	1	$	1	6	H	H	H	M	2	3	3	3	3	3	2	3	3	4	3	3	2
PUMPS AND VALVES	1	$	1	6	H	H	H	M	3	3	3	3	3	3	3	3	3	4	2	3	2
TANKS AND LINES	3	$	1	6	H	H	H	M	2	3	3	3	3	3	3	3	3	4	3	3	2
SEALS AND OTHER COMPONENTS	3	$	2	6	H	H	H	M	2	3	3	3	3	3	2	3	3	3	2	3	3
ADJUST PRESSURE	4	1	2	6	H	H	H	M	3	4	3	3	2	4	3	3	3	4	3	3	3
INSPECT AND REPAIR																					
OIL DILUTION SYSTEM	+		2	4	H		H	M	2		3	3	3		3	3	2		3	3	2
CHECK AND SERVICE																					
OIL DILUTION SYSTEM	+	-	2	4	H	H	H	M	2	3	2	3	2	4	2	3	2	4	3	3	2

NOTE IDENTIFY TYPES OF LUBRICATION SYSTEMS-THEORY ONLY

TABLE 24. IGNITION SYSTEMS

	N				F				T				M				I				AR
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	
IDENTIFY SPECIAL DANGERS OF HIGH ENERGY SYSTEMS	5	1	2	4	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3	3
CHECK AND SERVICE																					
TURBINE IGNITION SYSTEMS	5	+	1	3	H	H	H	M	4	3	3	3	3	4	2	3	3	4	3	3	2
LOW TENSION SYSTEMS	-	-	1	4	L	H	H	M	3	4	3	3	3	3	3	3	3	4	3	3	2
INSPECT AND REPAIR																					
LOW TENSION SYSTEMS	$	-	2	5	H	H	H	M	2	3	3	3	2	5	2	3	2	4	3	3	2
BOOSTER STARTING SYSTEMS	$	-	1	6	H	H	H	H	2	3	3	3	2	4	2	3	2	4	3	3	2
TURBINE IGNITION SYSTEMS	4	$	1	4	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	2
CLASSIFY TYPES OF MAGNETOS	-		1	7	L		H	H	3		1	3	3		1	3	4		3	3	1
CHECK AND SERVICE																					
BOOSTER STARTING SYSTEMS	-	-	1	3	L	H	H	M	3	4	3	3	2	4	3	3	3	4	3	3	3
BATTERY IGNITION SYSTEMS	$	-	1	5	H	H	H	M	3	4	3	3	3	4	3	3	4	4	3	3	3
HIGH TENSION SYSTEMS	-	-	1	6	L	H	H	H	3	3	3	3	2	4	3	3	3	3	3	3	3
INSPECT AND REPAIR																					
BATTERY IGNITION SYSTEMS	$	$	1	5	H	H	H	H	2	3	3	3	2	4	2	3	2	4	3	3	2
HIGH TENSION SYSTEMS	$	-	2	5	H	H	H	H	2	2	3	3	2	3	2	3	2	3	3	3	2

NOTE: IDENTIFY SPECIAL DANGERS OF HIGH ENERGY SYSTEMS-THEORY ONLY

TABLE 25. FUEL METERING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INSPECT, MAINTAIN, AND TEST																					
GAS TURBINE FUEL CONTROL UNITS	1	+	1	2	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	2
ADI SYSTEMS	-	-	1	1	L	L	H	M	2	2	3	3	2	4	2	3	2	4	1	1	2
CARBURETOR DE-ICING AND ANTI-ICING	-	-	2	5	L	L	H	H	2	2	3	3	2	4	2	3	2	4	3	3	3
CHECK AND SERVICE WATER INJECTION SYSTEM	3	$	1	2	H	H	H	M	2	4	3	3	3	4	3	3	2	4	2	3	2
DETERMINE CAUSES OF DETONATION, AUTO IGNITION, ETC.			1	6			H	M			4	3			3	3			3	3	2
INSPECT, MAINTAIN, AND TEST																					
FLOAT CARBURETORS			+	7			H	H			3	3			3	3			3	3	3
INJECTION CARBURETORS	-	-	1	5	L	L	H	H	2	2	3	3	2	4	3	3	2	4	3	3	2
INJECTION NOZZLES	-	-	2	6	H	L	H	M	2	2	3	3	2	4	2	3	2	4	3	3	2
TRIM TURBINE POWERPLANTS	3	$	1	2	H	H	H	M	3	4	3	3	5	3	3	3	4	4	3	3	2

TABLE 26. INDUCTION SYSTEM

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INSPECT AND MAINTAIN																					
CARBURETOR INTAKE AND INTAKE PIPES	+	-	2	7	H	L	H	H	3	3	3	3	3	3	2	3	3	3	3	3	3
HEAT EXCHANGERS	1	-	2	6	H	H	H	H	3	3	3	3	3	4	3	3	3	4	3	3	2

TABLE 27. PROPELLER (GENERAL)

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
PERFORM SPECIALIZED PROPELLER INSPECTIONS	-	-	+	4	H	H	M	M	2	3	3	3	3	5	2	3	3	3	4	3	2
PERFORM PROPELLER TRACK	-	-	1	7	H	L	H	M	2	3	3	3	2	3	3	3	3	4	3	3	3
USE UNIVERSAL PROTRACTOR	-	-	2	5	H	L	H	M	2	3	3	3	2	3	3	3	3	4	3	3	3
APPLY THEORY OF THRUST	-	-	1	6	L	L	L	M	3	3	3	3	3	2	2	3	2	3	3	3	1
USE PROPELLER SPECIFICATIONS	-	-	2	6	H	L	H	M	3	1	3	3	5	2	2	3	3	3	3	3	3
APPLY THEORY OF BALANCE	-	-	+	4	H	H	L	M	3	3	3	3	2	3	2	3	2	3	3	3	1
IDENTIFY SPECIAL PROPELLER LUBRICANTS	-	-	1	4	H	H	H	M	1	4	3	3	2	3	3	3	3	3	3	3	2

TABLE 28. FIXED PITCH PROPELLERS (WOOD)

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
REMOVE AND INSTALL				5				L				3				3				3	D
REFINISH PROPELLER				2				L				3				3				3	D
BALANCE VERTICAL AND HORIZONTAL				1				L				3				3				3	D

TABLE 29. FIXED PITCH PROPELLERS (METAL)

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
REPAIR PROPELLER (MINOR)		-	1	6		L	H	M		2	3	3		3	3	3		3	3	3	2
REMOVE AND INSTALL			1	6			H	M			3	3			3	3			3	3	3
REFINISH PROPELLER			$	2			H	H			1	3			3	3			1	3	D
BALANCE VERTICAL AND HORIZONTAL			$	2			L	L			3	3			3	3			4	3	D

TABLE 30. GROUND ADJUSTABLE PROPELLERS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
REMOVE AND INSTALL			1	2			L	L			3	3			3	3			3	3	D
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			-	1			L	L			3	3			3	3			3	3	D
REPAIR BLADES AND HUB (MINOR)			1	2			L	L			3	3			3	3			3	3	D
REPITCH PROPELLER			$	1			L	L			3	3			2	2			2	2	D
BALANCE			$	+			L	L			3	3			3	3			3	3	D

TABLE 31. TWO POSITION AND CONSTANT SPEED PROPELLERS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY THEORY OF OPERATION			1	4			M	M			4	3			2	3			3	3	1
REMOVE AND INSTALL			2	5			L	L			3	3			3	3			3	3	3
CHECK OPERATION			2	5			L	M			3	3			3	3			3	3	2
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS			-	1			L	L			3	3			3	3			3	3	D
BALANCE PROPELLER			$	+			L	L			4	3			3	3			4	4	1
OVERHAUL PROPELLER			-	+			M	L			3	3			3	3			3	3	D

TABLE 32. CONSTANT SPEED FEATHERING PROPELLERS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY THEORY OF OPERATION		-	2	5		H	H	M		3	3	3		2	3	3		4	3	3	1
REMOVE AND INSTALL		$	2	6		M	M	M		1	3	3		2	3	3		3	3	3	3
CHECK OPERATION		-	2	6		H	H	M		4	3	3		2	3	3		4	3	3	2
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS		-	+	1		H	H	M		4	3	3		3	3	4		4	3	4	1
BALANCE PROPELLER		-	$	+		H	L	M		3	3	3		3	3	4		4	4	4	1
OVERHAUL PROPELLER		-	-	+		H	H	M		4	3	3		3	2	2		4	3	3	D

TABLE 33. REVERSIBLE PROPELLERS RECIPROCATING ENGINES

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY THEORY OF OPERATION	-	-	1	1	L	H	H	M	3	4	1	3	3	3	1	3	3	4	4	3	1
REMOVE AND INSTALL	-	-	1	+	L	L	M	M	1	3	3	3	3	3	3	3	2	4	3	3	1
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS		-	+	+		H	H	M		4	3	3		3	3	3		4	4	3	1
OVERHAUL PROPELLER		-	-	+		H	M	M		4	3	3		3	3	3		4	3	3	D

TABLE 34. REVERSIBLE PROPELLERS TURBINE ENGINES

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY THEORY OF OPERATION	$	-	1	2	H	H	H	M	3	3	3	3	3	2	3	3	3	4	4	3	1
REMOVE AND INSTALL	$	-	1	2	H	M	H	M	3	3	3	3	3	3	3	3	3	4	4	3	3
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS	-	-	+	+	H	H	M	L	1	3	3	3	2	3	3	3	4	4	4	3	1
OVERHAUL PROPELLERS		-	-	$		H	M	L		2	3	3		3	2	3		4	4	3	D
CHECK AND SERVICE TURBOPROP ENGINE BRAKE					H	H	H	L	2	3	3	3	3	3	3	3	2	4	4	3	1

TABLE 35. GOVERNORS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
LINE INSPECTION AND ADJUSTMENTS	+	-	1	5	H	H	H	M	3	4	3	3	3	3	3	3	3	3	3	3	2
APPLY THEORY OF OPERATION	$	$	2	5	H	H	H	M	3	3	3	3	3	3	3	3	3	4	3	3	1
SERVICE SYNCHRONIZATION SYSTEM	$	-	1	3	H	H	H	M	2	4	3	3	3	3	3	3	3	4	3	3	1
DISASSEMBLE AND ASSEMBLE PER MANUFACTURER'S SPECIFICATIONS		-	$	1		H	H	M		2	3	3		3	2	3		4	3	3	D
CHECK AND SERVICE BLEED VALVE GOVERNOR	1	-	+	1	M	H	H	L	2	4	3	3	3	4	3	3	3	4	3	3	2
BENCH TEST		-	$	+		H	H	L		3	3	3		3	3	3		4	3	3	1
OVERHAUL GOVERNOR		-	$	1		H	H	L		2	3	3		3	3	3		4	3	3	D

TABLE 36. DRAFTING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
USE AND INTERPRET STANDARD BLUEPRINT INFORMATION	3	7	3	4	L	H	H	M	2	2	3	3	2	3	2	3	3	4	2	1	3
CARE OF BLUEPRINTS	2	1	2	4	H	H	H	M	3	3	3	3	2	3	3	3	3	3	2	1	3
INTERPRET AND APPLY DATA IN TITLE BLOCK, BILL OF MATERIALS, ETC.	-	6	2	2	H	H	H	M	2	2	3	3	2	3	2	3	2	3	2	2	3
DRAW SHOP SKETCHES	-	+	+	3	H	H	H	M	2	3	3	3	2	3	2	3	2	3	2	1	3
USE APPROPRIATE SYMBOLS I.E., HYDRAULIC, ELECTRICAL, ETC.	1	4	2	1	H	H	H	L	3	2	3	3	2	2	3	2	1	3	3	2	3
USE AND CARE OF ESSENTIAL DRAFTING INSTRUMENTS AND EQUIPMENT	-	+	-	1	L	H	M	M	2	2	3	3	2	3	2	3	1	1	2	2	2
DRAW PROJECTIONS		$	-	1		H	M	L		2	3	3		3	3	3		4	3	1	2
USE OF SPECIFICATIONS AND DRAFTING ROOM MANUALS		+	$	1		H	H	L		2	3	3		3	2	3		4	2	1	2
DRAW INTERSECTIONS AND DEVELOPMENTS		$	$	1		H	H	M		2	3	3		3	3	3		4	3	3	2
DRAW LINES, DIMENSIONS, SECTIONS, SCALES, ETC.	-	+	$	2	M	H	H	L	2	2	3	3	1	3	2	3	1	4	4	3	2
DRAW TECHNICAL WORKING DRAWINGS		+	-	1		H	L	M		2	3	3		3	3	3		4	2	1	2

TABLE 37. WEIGHT AND BALANCE

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
USE SPECIFICATIONS, DATA SHEETS, AND AIRCRAFT LISTING	$	-	1	5	M	M	H	H	3	4	3	3	3	4	3	3	3	2	3	3	3
PREPARE AND WEIGH AIRCRAFT		+	1	5	L	M	M	H	2	3	3	3	3	3	3	3	3	3	3	2	3
MEASURE MOMENT ARM		-	1	5	L	M	H	H	3	4	3	3	3	4	3	3	2	2	3	2	3
COMPUTE WEIGHT AND BALANCE		-	+	5	L	M	H	H	3	4	3	3	3	4	3	3	3	2	3	3	3
CORRECT FOR ADVERSE CONDITIONS OR EFFECTS OF IMPROPER LOADING	-	-	+	4	H	L	M	H	4	4	3	3	3	4	3	3	4	2	3	3	3
RECORD WEIGHT AND BALANCE DATA	$	-	1	5	L	M	L	H	1	4	3	3	3	4	3	3	3	2	3	2	3
USE TERMINOLOGY AND SYMBOLS	-	-	+	5	L	M	M	H	2	2	3	3	4	4	3	3	2	2	3	3	3
USE LOADING GRAPHS, CENTER OF GRAVITY ENVELOPES AND LOADING SCHEDULES		-	+	5	L	M	M	H	2	2	3	3	3	4	3	3	2	3	3	3	3
USE FAA APPROVED FORMS	+	-	1	5	H	M	H	H	3	3	3	2	3	2	3	3	2	4	3	2	3

TABLE 38. AIRCRAFT MATERIAL AND PROCESSES

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
IDENTIFY STANDARD HARDWARE AND MATERIALS	5	3	8	9	H	H	H	H	3	3	2	3	2	3	1	3	3	3	3	3	3
USE THE TECHNICAL TERMINOLOGY COMMON TO MATERIALS UTILIZED IN AIRFRAMES AND PROPULSION UNITS	4	2	1	5	H	H	H	H	3	3	3	3	1	3	3	3	3	4	2	1	3
DEVELOP AN UNDERSTANDING OF STRUCTURE AND COMPOSITION OF METALS AND THEIR ALLOYS SUCH AS SAE STEELS, CORROSION RESISTANT STEEL, COPPER, NICKEL, ALUMINUM, MAGNESIUM, TITANIUM, SPECIAL HIGH TEMPERATURE METALS, ETC.	2	1	2	5	H	H	H	H	3	3	3	3	3	3	3	3	3	4	2	3	3
IDENTIFY TYPES OF CORROSION AND PREVENTIVE MEASURES	3	2	1	5	H	H	H	M	3	3	3	3	3	3	2	3	3	4	2	3	3
IDENTIFY PIPING COLOR CODING	4	2	6	4	H	H	H	H	1	1	3	3	1	1	1	2	2	2	3	3	2
PERFORM BASIC HEAT TREATING AND ANNEALING PROCESSES	-	$	$	2	H	H	L	M	3	3	3	3	3	2	3	3	3	3	3	1	2
IDENTIFY PHYSICAL PROPERTIES OF MATERIALS	1	+	+	4	H	H	H	H	2	3	3	3	3	3	1	3	3	3	3	3	2
IDENTIFY MECHANICAL PROPERTIES OF MATERIALS	2	+	+	4	H	H	H	H	2	3	3	3	3	3	3	3	3	3	2	3	2
APPLY PRINCIPLES OF ADHESIVE BONDING	2	1	+	3	H	H	H	M	3	3	3	3	3	3	3	3	3	3	3	3	2
UTILIZE BASIC ECONOMIC AND ENGINEERING CRITERIA IN SELECTION OF MATERIALS	1	1	+	3	H	H	M	M	2	3	3	3	2	2	2	3	3	3	2	1	2
IDENTIFY WINDSHIELD AND WINDOW MATERIALS	3	1	1	5	H	H	H	H	1	3	3	3	2	3	3	3	3	3	3	3	2
USE HIGH ENERGY FORMING PROCESSES			-	+	H	H	H	L	3	3	3	3	3	3	3	3	4	4	3	3	1

TABLE 39. INSPECTION FUNDAMENTALS

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INSPECT FOR GENERAL SOURCE OF WEAR AND DETERIORATION	5	2	4	8	H	H	H	H	3	3	3	3	3	3	2	3	3	3	2	3	3
COMPLETE TYPICAL REPORT FORMS AND STATUS TAGS	3	2	2	4	H	H	H	H	3	3	2	3	2	3	2	2	3	3	3	3	3
USE PRECISION MEASURING DEVICES - MICROMETERS, HEIGHT GAGES, ETC.	3	2	3	7	H	H	H	H	3	3	2	3	3	3	2	3	3	4	2	3	3
USE MANUFACTURER'S INSPECTION DATA	2	3	4	6	H	H	H	H	3	1	2	3	3	3	2	3	3	3	2	1	3
USE NON-DESTRUCTIVE TESTING																					
PENETRANTS	3	1	1	6	M	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3	3
USE FUNDAMENTALS OF STATISTICAL INSPECTION	$	$	+	1	H	H	H	M	3	3	2	3	3	2	2	3	3	3	2	3	2
USE NON-DESTRUCTIVE TESTING																					
MAGNETIC PARTICLE	+	+	+	2	H	H	H	H	3	3	3	3	3	3	3	3	3	3	3	3	2
CHEMICAL ETCHING	-	$	$	3	H	H	H	M	3	3	3	3	3	3	3	3	3	3	3	3	2
HARDNESS	-	$	-	+	H	H	M	H	4	3	3	3	3	3	3	3	4	3	3	3	2
USE DESTRUCTIVE TESTING																					
TENSION			-	-			H	M			3	3			3	3			4	3	1
BENDING			-	-			H	H			3	3			3	3			4	3	1
IMPACT			-	-			H	L			3	3			3	3			4	3	1
USE NON-DESTRUCTIVE TESTING																					
ULTRA SONIC	$	$	-	1	H	H	L	L	3	3	3	3	3	3	3	3	3	3	4	3	1
RADIOGRAPHY (X-RAY)	-	-	-		M	H	L	L	3	3	3	3	3	3	3	3	4	3	4	3	1

TABLE 40. AIRCRAFT AND ENGINE INSPECTION

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
PERFORM AND RECORD INSPECTIONS PER MANUFACTURER'S FAA OR PROGRESSIVE REQUIREMENTS	5	1	2	7	H	H	H	H	3	3	3	3	3	3	3	3	3	4	3	3	3
INSPECT AIRCRAFT (WALK AROUND)	6	1	3	8	H	H	H	H	3	3	3	3	3	4	2	3	3	3	3	3	3
USE INSPECTION GUIDES	5	+	3	8	H	H	H	H	2	2	3	3	3	3	3	3	3	2	3	3	3
INSPECT AIRCRAFT (ANNUAL)	4	$	3	7	H	H	H	H	3	3	3	3	3	3	1	3	3	3	3	3	3
USE MANUFACTURER'S SERVICE BULLETINS	3	2	5	8	H	H	H	H	3	3	3	3	3	3	2	3	3	3	2	3	3
INSPECT AIRCRAFT (OVERHAUL CHECKS)	$	+	2	6	H	H	H	H	3	3	3	3	3	3	1	3	3	4	3	3	3
USE GENERAL AVIATION INSPECTION AIDS SUMMARY	+		3	8	H		H	H	3		3	3	3		1	3	3		3	3	3
CHECK STORAGE STATUS OF NON-ACTIVE AIRCRAFT	2		1	4	H	H	H	H	3	1	3	3	3	1	3	3	4	2	3	3	3

TABLE 41. GROUND SUPPORT EQUIPMENT

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
USE HYDRAULIC EQUIPMENT	5	+	2	7	H	H	H	H	3	2	3	3	3	2	2	3	3	4	2	3	3
USE PNEUMATIC EQUIPMENT	6	1	1	6	H	H	H	H	2	3	3	3	3	4	2	3	3	3	2	3	3
USE ELECTRICAL EQUIPMENT	4	1	2	7	H	H	H	H	2	3	3	3	3	4	2	3	3	3	2	3	3
USE FUELS, LUBRICANTS AND FLUIDS	6	2	3	7	H	H	H	H	2	3	3	3	3	5	2	3	3	3	3	3	3
USE GROUND FIRE PROTECTION	7	2	6	7	H	H	H	H	2	3	3	3	3	4	2	3	3	4	2	3	3
USE LINE STARTING EQUIPMENT	6	1	3	7	H	H	H	H	2	3	3	3	3	3	2	3	3	3	2	3	2
DRIVE FUEL TRUCKS	3	+	+	3	H	H	H	H	2	1	3	3	3	2	2	3	3	3	2	3	D
USE GROUND AIR CONDITIONER	2		+	2	H		M	M	2		3	3	3		2	3	3		4	3	2

TABLE 42. GROUND HANDLING

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
USE STANDARD LINE AND TAXI SIGNALS	6	+	3	6	H	H	H	H	2	2	2	3	2	2	1	2	3	3	3	2	2
USE TOW BARS AND TOWING EQUIPMENT	6	2	2	7	H	H	H	H	2	3	3	3	3	3	2	3	3	3	2	1	2
JACK AIRCRAFT	5	1	2	8	H	H	H	H	3	3	3	3	3	3	2		3	3	2	3	3
SPOT AND MOOR AIRCRAFT	6	+	2	7	H	H	H	H	2	3	3	3	3	3	3	3	3	4	3	3	3
FUEL AIRCRAFT	4	+	2	6	H	H	H	H	3	2	3	3	2	2	3	2	3	4	3	3	3
PERFORM PRE-FLIGHT SERVICING	6	1	3	4	H	H	H	H	3	3	3	3	3	3	2	2	3	3	3	3	3
PERFORM POST-FLIGHT SERVICING	5	1	3	4	H	H	H	H	3	3	3	3	3	3	2	2	3	3	3	3	3
TAXI AIRCRAFT	4	$	1	8	H	H	H	H	3	3	3	3	3	3	2	3	4	4	2	1	2
HOIST AIRCRAFT	1	$	1	4	H	H	H	M	2	3	3	3	4	3	2	3	3	3	3	3	2

TABLE 43. CLEANING AND CORROSION CONTROL

	N				F				T				M				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
IDENTIFY APPLICATIONS AND LIMITATIONS OF																					
CHEMICAL SOLVENTS AND PAINT REMOVERS	1	+	1	6	H	H	H	H	3	3	3	3	3	3	2	3	3	3	3	3	2
USE CLEANING EQUIPMENT AND PROCEDURES FOR																					
VAPOR DEGREASING	+	1	+	2	H	H	H	M	2	2	3	3	3	3	3	3	3	2	3	3	2
INSPECT FOR EVIDENCE OF CORROSION IN CRITICAL AREAS	2	2	4	6	H	H	H	H	3	3	3	3	3	3	2	3	3	3	3	3	3
IDENTIFY APPLICATIONS AND LIMITATIONS OF																					
SOAPS AND DETERGENTS	1	+	1	6	H	H	H	H	3	3	3	3	3	3	2	2	3	3	3	3	3
WINDOW AND WINDSHIELD CLEANING AGENTS	1	+	2	6	H	H	H	H	1	3	3	3	2	3	2	3	3	3	3	3	3
INSPECT AND DETERMINE ADEQUACY OF CLEANING PERFORMED ON AIRPLANES	+	$	1	5	H	H	H	H	3	3	3	3	3	3	2	2	3	3	2	1	3
APPLY PRINCIPLES OF AIRPLANE CLEANING AND CORROSION CONTROL	1	+	1	6	H	H	H	H	2	4	3	3	3	3	2	3	3	3	1	3	3
USE INTERIOR CLEANING EQUIPMENT AND PROCEDURES	1	+	1	4	H	H	H	H	3	3	3	3	3	3	2	3	3	3	3	3	2
USE CARBON REMOVERS	+	-	1	6	H	H	H	H	3	2	3	3	3	2	2	3	2	2	3	3	2
USE SAND, SHELL, GRIT, AND VAPOR BLASTING		-	+	3		H	H	H		3	3	3		3	2	3		3	1	3	2
USE CLEANING EQUIPMENT AND PROCEDURES FOR																					
ELECTRICAL COMPONENT CLEANING	-	1	$	3	H	H	H	H	3	2	3	3	3	3	3	3	3	2	2	3	2
ULTRASONIC DEGREASING	$	1	-	1	H	H	H	H	2	2	3	3	3	3	3	3	3	3	2	1	1

TABLE 44. MATHEMATICS

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
ADD, SUBTRACT, MULTIPLY AND DIVIDE	6	9	8	8	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1	3
READ AND INTERPRET GRAPHS AND CHARTS	3	3	2	5	H	H	H	M	3	3	3	3	1	1	1	1	2	3	1	1	3
CALCULATE RATIOS, PROPORTIONS AND PERCENTAGES	1	$	+	3	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1	3
PERFORM ALGEBRAIC OPERATIONS INVOLVING SUBTRACTION, ADDITION MULTIPLICATION AND DIVISION OF POSITIVE AND NEGATIVE NUMBERS	-	+	+	4	L	H	H	H	2	3	3	3	1	1	1	1	1	3	1	1	2
PERFORM LAYOUTS UTILIZING FUNDAMENTALS OF GEOMETRIC CONSTRUCTION	$	$	+	3	L	H	H	M	3	3	3	3	1	1	1	1	1	2	1	1	2
EXTRACT ROOTS AND RAISE NUMBERS TO GIVEN POWERS	$	$	+	2	H	H	H	M	2	3	3	3	1	1	1	1	1	1	1	1	1
PERFORM DESCRIPTIVE GEOMETRY AS APPLIED TO TEMPLATE DEVELOPMENT AND LAYOUT	-	-	$	2	H	H	H	M	3	3	3	3	1	1	1	1	1	1	1	1	2
CALCULATE AREAS AND VOLUMES OF VARIOUS GEOMETRIC SHAPES	-	-	-	3	L	H	L	M	2	3	3	3	1	1	1	1	1	1	1	1	2
PERFORM CALCULATIONS COMMON TO RIGHT TRIANGLES AND USE OF TRIGONOMETRIC TABLES	-	$	$	2	L	H	H	M	2	3	3	3	1	2	1	1	1	2	2	1	1
PERFORM CALCULATIONS INVOLVING USE OF SLIDE RULE	-	-	-	1	L	H	L	L	2	2	3	3	1	1	1	1	1	1	1	1	1

TABLE 45. ENGLISH

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
READ, WRITE AND SPEAK THE ENGLISH LANGUAGE	8	9	9	9	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1	3
WRITE CLEAR, CONCISE, GRAMMATICALLY CORRECT TECHNICAL REPORTS NORMALLY EXPECTED OF CERTIFICATED MECHANICS	5	6	3	7	H	H	H	H	2	3	2	3	1	1	1	1	1	1	1	1	3
USE DICTIONARY AND STANDARD REFERENCE BOOKS	6	6	4	7	H	H	H	H	3	3	2	3	1	1	1	1	1	1	1	1	3
READ PERTINENT TECHNICAL DATA WITH COMPREHENSION	6	9	8	8	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1	3

TABLE 46. PHYSICS

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
PERFORM CALCULATIONS INVOLVING MECHANICS SUCH AS LEVERS, PULLEYS, INCLINED PLANES, LINEAR MOTION, ETC.	$	-	$	3	H	H	H	H	3	3	3	3	1	1	1	1	1	1	1	1	2
SOLVE GAS AND FLUID PROBLEMS SUCH AS PRESSURE, VOLUME, PASCAL'S LAW, BERNOULLI'S PRINCIPLE, ETC.	$	$	-	1	L	H	H	M	3	3	3	3	1	1	1	1	1	3	1	1	2
PERFORM TEMPERATURE CONVERSIONS, PROBLEMS INVOLVING RELATIONSHIPS OF GASSES AND PRESSURES AND MECHANICAL EQUIVALENTS OF HEAT	$	$	-	1	H	H	H	L	3	3	3	3	1	1	1	1	2	3	1	1	2
PERFORM NECESSARY CALCULATIONS TO UNDERSTAND EFFECT OF SPEED OF SOUND, FREQUENCY, PRESSURE, LOUDNESS, REFLECTION OF SOUND WAVES, ETC.				+		L	H	L		3	3	3		1	1	2		3	4	1	1

TABLE 47. CHEMISTRY

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
APPLY CHEMICAL PRINCIPLES TO																					
ELECTROLYSIS AND ITS EFFECT	$	-	$	2	M	M	H	H	3	3	3	3	1	1	1	1	1	3	1	1	1
BASIC CHEMISTRY OF FUELS, LUBRICANTS AND HYDRAULIC FLUIDS	+	$	$	2	H	M	H	H	3	3	3	3	1	1	1	1	3	3	3	1	1
THE BASIC CHEMISTRY OF PAINTS, LACQUERS AND THINNERS	+	-	-	3	H	H	H	H	3	3	3	3	1	1	1	2	1	3	3	1	1
THE CHEMICAL REACTIONS WITHIN THE BATTERIES	1	-	+	3	H	M	H	H	3	3	3	3	1	1	1	1	1	2	2	1	1
THE CHEMISTRY OF ADHESIVES AND SEALING MATERIALS	+	$	$	1	H	H	H	M	2	3	3	3	1	1	1	2	2	3	2	1	1
COMMON ELEMENTS AND ELEMENTARY COMPOUNDS SUCH AS SALTS, BASES AND ACIDS	+	-	$	2	M	L	H	M	3	3	3	3	1	1	1	2	1	1	1	1	1
THE CHEMISTRY OF PLASTICS BOTH CLEAR AND REINFORCED	$	-	-	2	H	H	H	M	3	3	3	3	1	1	1	2	3	3	1	1	1
THE COMPOSITION OF MATTER-MOLECULES, ATOMS AND ELECTRONS			$	+			H	M			3	3			1	1			2	1	1
THE CHEMISTRY OF NATURAL AND SYNTHETIC FABRICS		-	-	1		M	H	L		1	3	3		1	1	1		2	1	1	1
USE OF CHEMICAL SYMBOLS AND EQUATIONS		-	-	-		L	H	H		2	2	2		1	1	1		2	3	2	1
USE PERIODIC TABLE		-	-	-		M	M	L		2	2	2		1	1	1		2	2	1	1

TABLE 48. AIRCRAFT NOMENCLATURE

	N	F	T	A/S	I	A
	A O L S	A O L S	A O L S	A O L S	A O L S	R
USE PROPER AIRCRAFT NOMENCLATURE	8 7 9 8	H H H H	2 2 3 3	1 1 1 1	2 3 3 1	3
CLASSIFY AIRCRAFT AS TO PROPULSION DEVICES, WING ARRANGEMENT, PURPOSE, LANDING GEAR SYSTEMS, ETC.	4 1 8 7	H H H H	3 3 3 3	1 2 1 1	3 3 2 1	3
APPLY FAA AIRCRAFT CATEGORIES AND DEFINITIONS AS FOUND IN APPROPRIATE PUBLICATIONS SUCH AS FAR 1, 21, 23, ETC.	3 $ 7 7	H H H H	3 1 3 3	1 1 1 1	2 3 3 1	3

TABLE 49. THEORY OF FLIGHT

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
INTERPRET THEORY OF FLIGHT IN RELATION TO																					
REFERENCE AXES OF AIRCRAFT	1	-	3	5	H	H	H	H	3	3	3	3	1	1	1	1	1	2	2	1	2
FUNCTION OF CONVENTIONAL CONTROLS AND CONTROL SURFACES	4	+	3	6	H	H	H	H	3	1	3	3	1	1	1	1	1	3	2	1	2
HIGH LIFT DEVICES SUCH AS FLAPS, SLATS, ETC.	4	+	1	6	H	H	H	H	3	1	3	3	1	1	1	1	3	3	3	1	2
PROPERTIES OF THE EARTH'S ATMOSPHERE	2	-	2	4	H	M	H	M	3	3	3	3	1	1	1	1	1	2	2	1	1
AIRCRAFT MANEUVERS SUCH AS TURNS, SKIDS, STALLS, ETC.	2	$	+	4	H	H	H	H	3	3	3	3	1	1	1	1	1	3	3	1	2
FORCES ACTING ON AN AIRFOIL AND AIRPLANE	3	$	2	5	H	H	H	H	3	3	3	3	1	1	1	1	1	2	2	1	2
UNCONVENTIONAL CONTROLS AND CONTROL SURFACES	3	+	2	4	H	H	H	H	3	1	3	3	1	1	1	1	3	3	2	3	1
LOADS AND EFFECT OF TURBULENCE AND SPEED	2	$	1	4	H	H	H	H	3	3	3	3	1	1	1	1	2	3	3	1	2
WING LOADING, POWER LOADING, MANEUVERING SPEED, ETC.	$	-	1	3	H	M	H	M	3	3	3	3	1	1	1	1	1	2	2	1	2
ROTARY WING	-	-	$	1	M	M	H	M	3	3	3	3	1	1	1	1	1	2	4	1	2
ROTORCRAFT FLIGHT CONTROLS AND THEIR EFFECTS	-		$	1	M	M	H	M	2	2	3	3	1	1	1	1	1	2	4	1	2
THRUST TORQUE AND TORQUE CORRECTION AS APPLIED TO ROTORCRAFT	-		-	1	M	M	H	M	1	2	3	3	1	1	1	1	1	2	4	1	2

TABLE 50. FAR AND RELATED PUBLICATIONS

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
USE SPECIFICATIONS, DATA SHEETS, MANUALS, AND PUBLICATIONS ON AIRCRAFT, ENGINES AND PROPELLERS	6	9	6	9	H	H	H	H	3	2	3	3	1	1	1	1	3	3	3	1	3
USE REQUIRED FEDERAL AIR REGULATIONS	4	2	5	8	H	H	H	H	2	2	3	3	1	1	1	1	2	2	3	1	3
INTERPRET AND USE SPECIFICATIONS SUCH AS MS, AC, AN, AND ANA, NAS AND TYPICAL MANUFACTURER'S MANUALS	6	2	8	8	H	H	H	H	2	2	3	3	1	1	1	1	2	2	3	1	3
INTERPRET AND USE ATA SPECIFICATION 100	4	2	1	1	H	H	H	H	2	2	3	3	1	1	1	1	2	2	3	1	2
USE FLIGHT SAFETY MECHANICS BULLETINS	5	1	5	6	H	H	H	H	3	3	3	3	1	1	1	1	3	3	3	1	3
KNOW HOW AND WHERE TO FIND PERTINENT DATA IN FAA SPECIFICATIONS	4	4	8	8	H	H	H	H	3	1	3	3	1	1	1	1	3	3	3	1	3
USE OF LOGBOOKS AND METHOD OF MAKING ENTRIES	5	1	1	8	H	H	H	H	3	3	3	3	1	1	1	1	3	3	3	1	3
USE AND DISPOSITION OF FAA FORMS	1	1	3	8	H	H	H	H	3	1	3	3	1	1	1	1	3	3	3	1	3
USE AIRWORTHINESS DIRECTIVES (FAR 39)	1	2	1	7	H	H	H	H	3	2	3	3	1	1	1	1	3	3	3	1	3
FILE AND INDEX PUBLICATIONS	1	1	1	6	H	H	H	H	3	2	3	3	1	1	2	1	3	3	3	1	2
USE OF TECHNICAL STANDARD ORDERS (TSO) AND SUPPLEMENTAL TYPE CERTIFICATE (STC)	1	1	5	7	H	H	H	H	3	2	3	3	1	1	1	1	3	3	3	1	3

TABLE 51. SHOP MANAGEMENT RESPONSIBILITIES

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
MAINTAIN REQURIED RECORDS	2	5	1	5	H	H	H	H	3	3	3	3	1	1	1	1	3	3	3	1	3
APPLY FAA REGULATIONS IN REPAIR STATION OPERATION	1	1	3	5	H	H	H	H	3	3	3	3	1	1	1	2	3	1	3	3	2
APPLY SHOP MANAGEMENT PRINCIPLES TO ORGANIZATION AND ASSIGNMENT OF PERSONNEL	+	+	1	5	H	H	H	H	3	3	3	3	2	1	1	1	3	3	2	1	2
PURCHASE PARTS AND SUPPLIES	-	$	+	4	H	H	H	H	3	1	3	3	1	2	1	1	2	2	2	1	2
PERFORM ELEMENTARY ACCOUNTING	+	$	+	4	H	H	H	H	3	3	3	3	1	2	1	1	1	3	3	1	2
PERFORM INVENTORY CONTROL OF MATERIALS, EQUIPMENT	$	$	+	4	H	H	H	H	3	1	3	3	2	1	1	1	2	2	1	1	2
PERFORM JOB ESTIMATING	+	+	+	4	H	H	H	H	3	2	3	1	2	1	1	1	2	2	1	1	2

TABLE 52. ETHICS AND LEGAL RESPONSIBILITIES

	N				F				T				A/S				I				A
	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	A	O	L	S	R
EMPLOY ETHICAL PRACTICES RELATED TO																					
JOB AND PRODUCT PRIDE AND CRAFTSMANSHIP	7	5	8	8	H	H	H	H	5	5	5	5					2	3	3	1	3
MECHANIC-EMPLOYER RELATIONSHIP	7	4	8	9	H	H	H	H	5	5	5	5					3	2	1	1	3
THE RESPONSIBILITIES OF AVIATION	8	4	8	9	H	H	H	H	5	5	5	5					3	3	2	1	3
PERSONAL CONDUCT AND INTEGRITY	6	5	8	9	H	H	H	H	5	5	5	5					3	3	2	1	3
PRACTICE THE LEGAL RESPONSIBILITIES OF																					
LIABILITY OF THE LICENSED MECHANIC	4	4	7	7	H	H	H	H	5	5	5	5					3	3	3	1	3
EMPLOY ETHICAL PRACTICES RELATED TO																					
MECHANIC-CUSTOMER RELATIONSHIP	4	+	8	8	H	H	H	H	5	5	5	5					2	3	3	1	3
PRACTICE THE LEGAL RESPONSIBILITIES OF																					
BAILMENT			4	3		H	H	H		5	5	5						3	3	1	2
MECHANICS LIENS		-	2	3		H	H	H		5	5	5						3	3	1	2

CONCLUSION

The National Advisory Committee has made a number of recommendations for changes in the levels originally established in 1966. These recommendations, based on the 1970 findings, lowered 35 percent of the task levels and raised 20 percent of the task levels. These recommendations for adjustment reflect the current requirements of the aviation industry and the necessity for readjustment of school curriculums.

On reviewing the National Advisory Committee's recommendations for adjustment of task levels, it was apparent that some of the major topics and tasks included thereunder received a significant change in level designation. Therefore, for reporting purposes, any major topic that had 50 percent or more of its task levels adjusted by the Advisory Committee is included in Figure 3.

Figure 3. READJUSTED TASK LEVELS

Major Topic	Increase T/K To:
Drafting	2 or 3
Weight and Balance	3
Aircraft and Engine Inspection	3
Ground Support Equipment	3
Ground Handling	2 or 3
Cleaning and Corrosion Controls	2 or 3
Shop Management Responsibilities	2

Major Topic	Decrease T/K To:
Painting and Finishing	2
Welding	2
Auto Pilot and Approach Control	1
Aircraft Fuel and Oil Measurement Control	1 and 2
Aircraft Landing Gear Electrical Units	1
Fire Detection and Extinguishing Systems	2
Ice and Rain Control	1
Reciprocating Engines	3
Turbine Engines	2
Lubricating Systems	2
Ignition Systems	2
Fuel Metering	2
Fixed Pitch Propellers (wood)	Delete
Ground Adjustable Propellers	Delete
Two Position and Constant Speed Propellers	1 or Delete
Constant Speed Feathering Propellers	1 or Delete
Reversible Propellers (recip.)	1 or Delete
Reversible Propellers (turbine)	1 or Delete
Governors	1 or Delete
English	3
Theory of flight	2

It is through periodic reviews as conducted in the resurvey that aviation maintenance technician school curriculums can be kept current. The recommendations made by the National Advisory Committee took into consideration the financial limitations and instructional equipment limitations associated with such schools.

A review of the two questionnaires used during the resurvey (see Table 53) indicates that there was little difference between the responses given on the original questionnaire (without 1965-1966 data added) and the modified questionnaire (containing the 1965-66 data information). The frequency, technical knowledge, and manipulative skill data were very similar, regardless of the sampling questionnaire used. The only fluctuation that might indicate a slight difference occurred in the reporting of industry training.

TABLE 53
PERCENT OF AGREEMENT BETWEEN ORIGINAL AND MODIFIED QUESTIONNAIRE RESULTS

COLUMN HEADINGS	AIRLINES	OVERHAUL	LARGE	SMALL
F	94.4	95.5	91.6	91.5
T/K	93.4	94.2	92.6	95.3
M/S	92.2	88.2	88.49	93.1
IND	91.1	84.9	87.6	89.3

The implications of the research findings should provide the FAA with an inexpensive method for keeping curriculum for aviation maintenance technician schools current with industry requirements. Through periodic comparisons between existing data and a recent, small sampling from the aviation industry, adjustments to curriculum could be made. The extent to which the curriculum can be kept current will be the extent to which schools will be able to train mechanics having the technical knowledge and skills required by the aviation industry.

APPENDIX A

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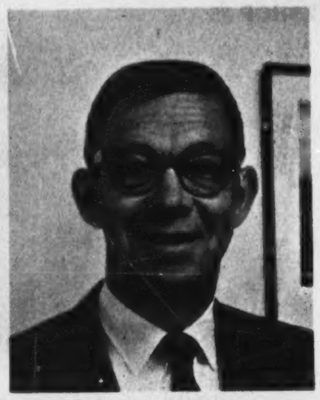

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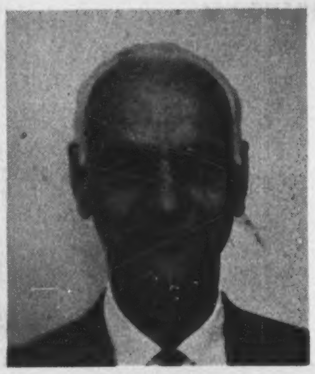

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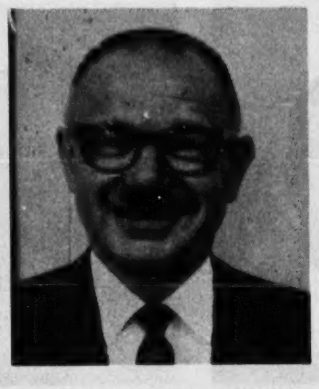

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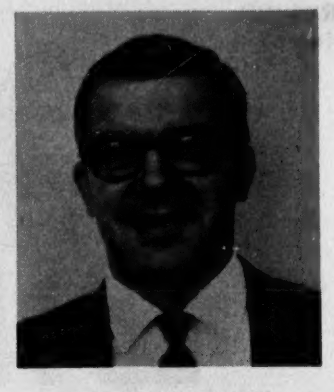

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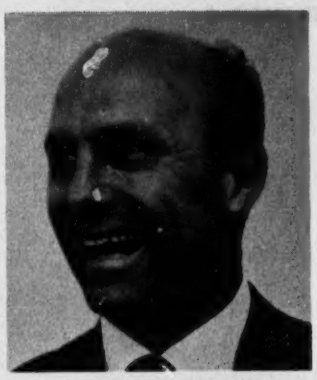

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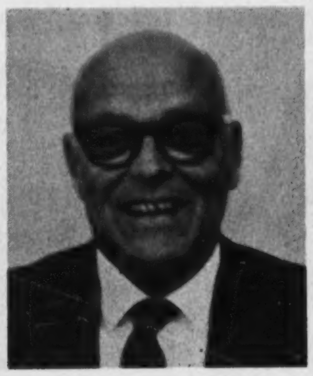

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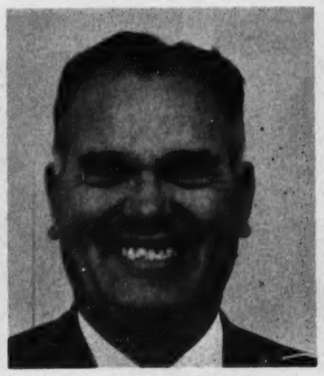

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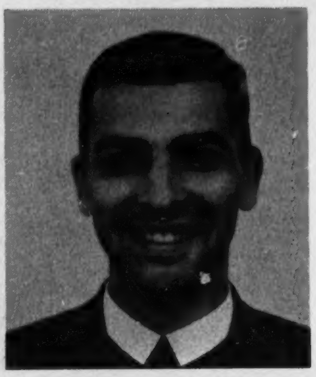

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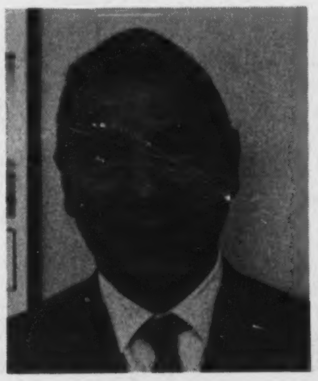
WORKSHOP #6



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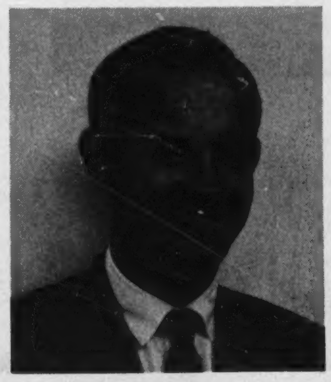

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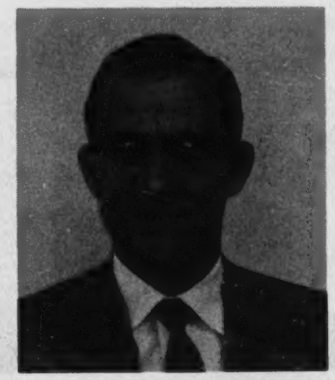

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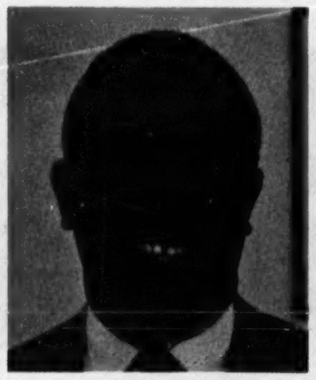

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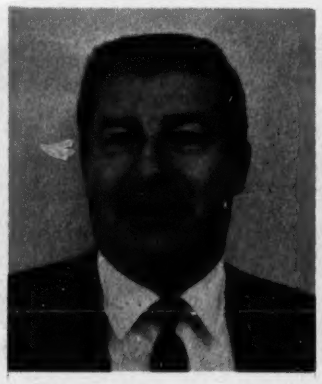

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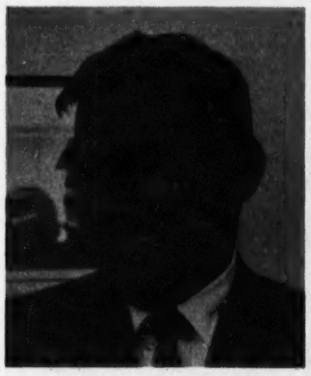

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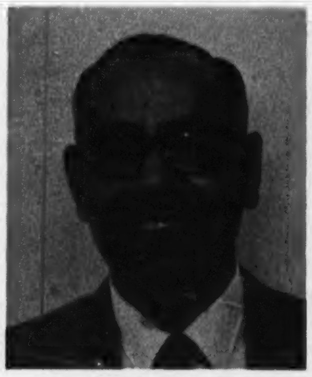

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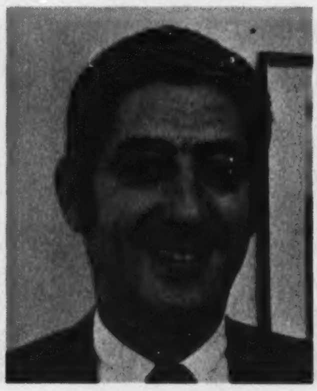

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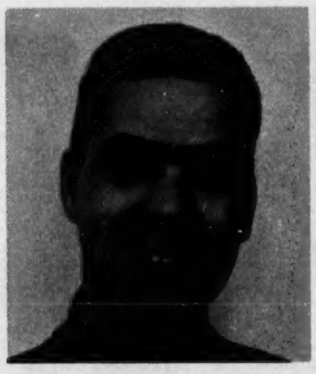

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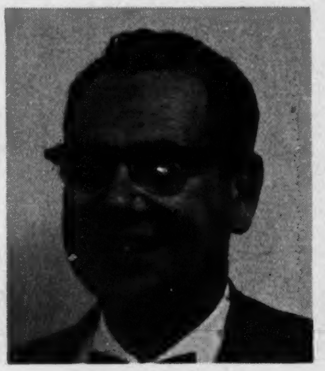
WORKSHOP #8



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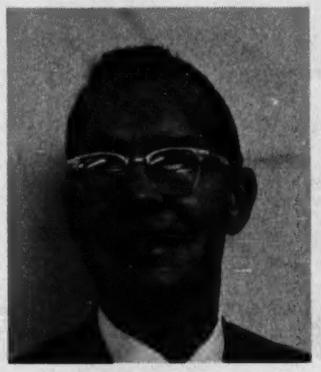

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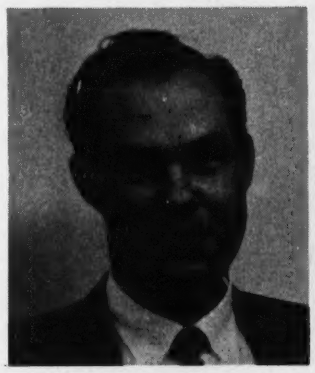

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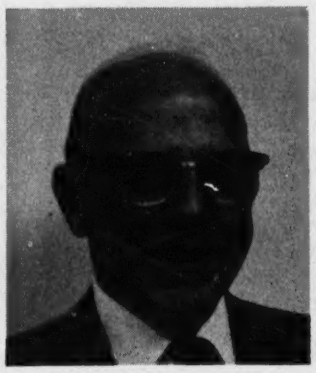

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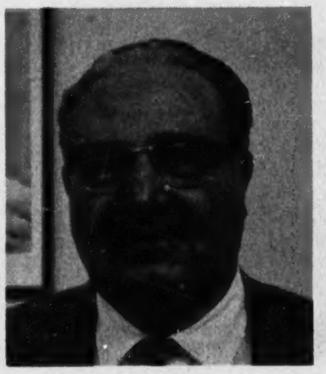

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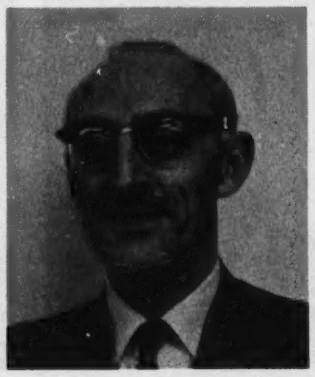

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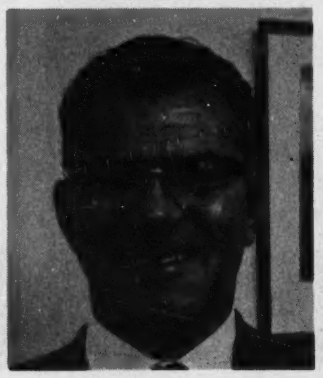

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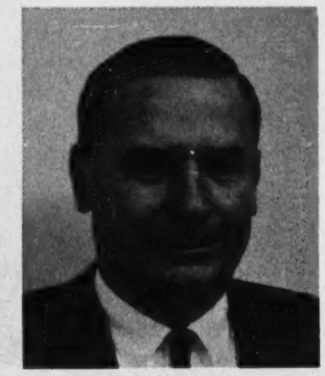

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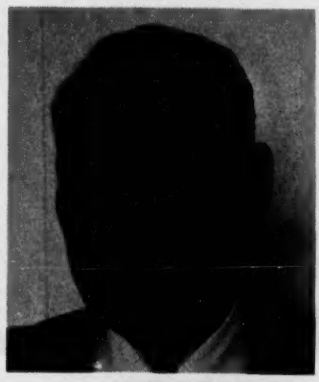

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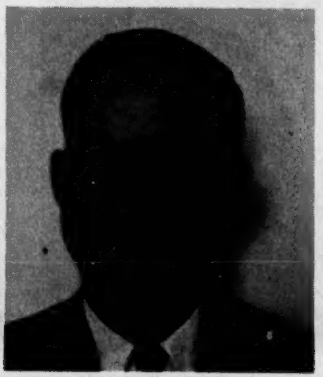

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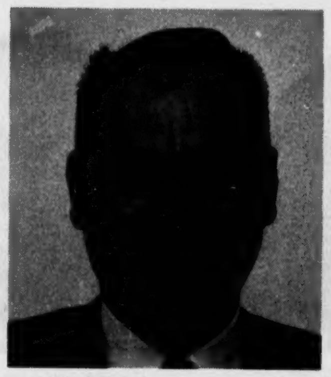

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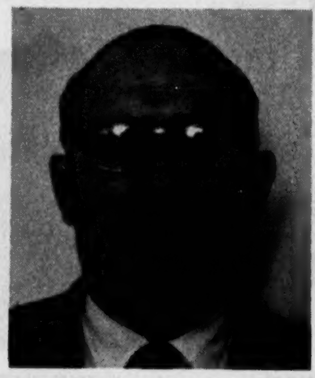

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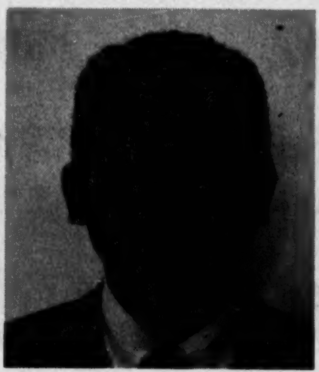

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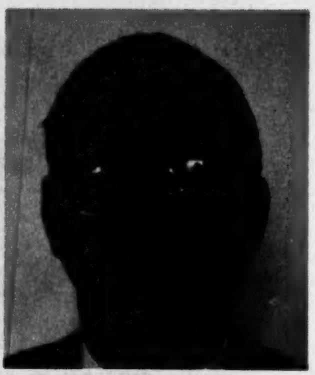

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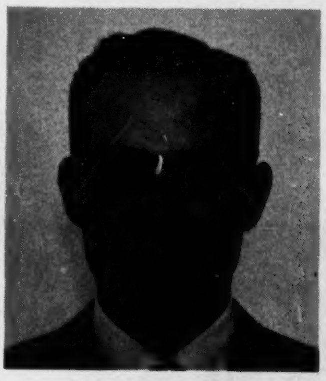

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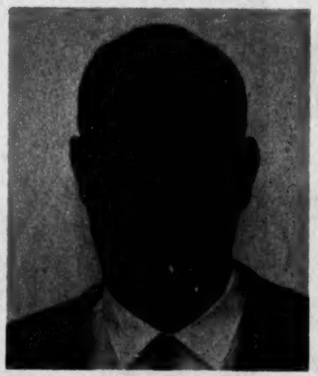

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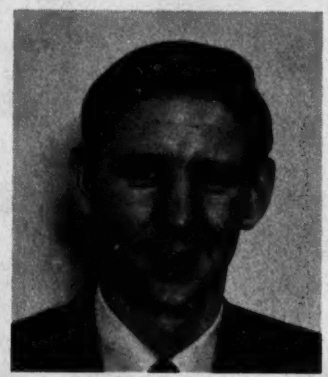

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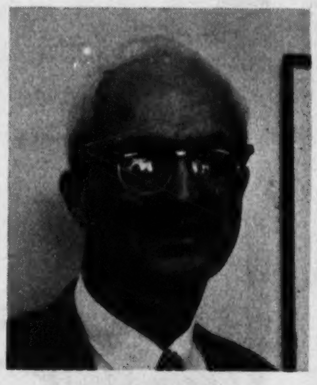

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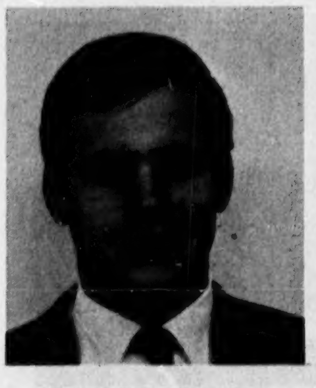

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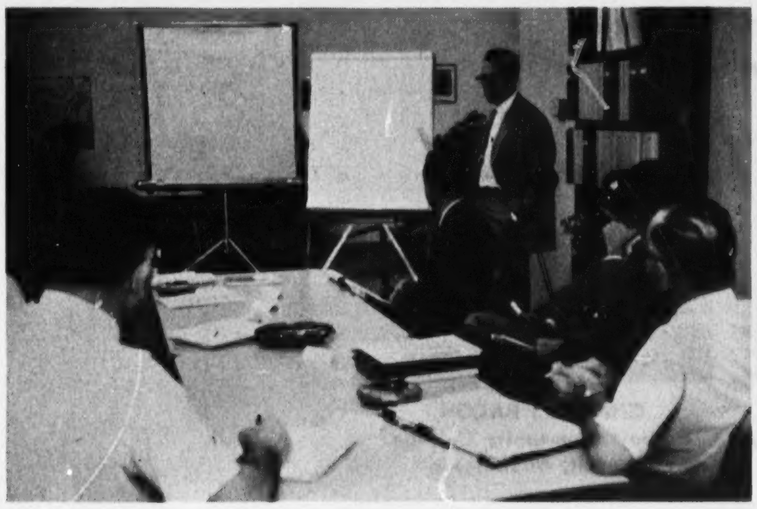

APPENDIX B

WORKSHOP ACTIVITIES and TIME DISTRIBUTION*

DAYS	AS	ASC	PTM	PSC	GC		AS	ASC	PTM	PSC	GC
FIRST WEEK											
Monday											
Introduction and Background	1.5	1.5	1.5	1.5	1.5		1.5	1.5	1.5	1.5	1.5
Student Performance Goals	2	2	2	2	2		2	2	2	2	2
Student Performance Goal Development	2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5
Industry Representative's Presentation	2	2	2	2	2		2	2	2	2	2
Tuesday											
Curriculum Development (Small Groups)	8	8	8	8	6		8	8	8	6	6
Industry Representative's Presentation	-	-	-	-	-		-	-	-	2	2
Wednesday											
Curriculum Development (Small Groups)	4	4	4	4	4		4	4	4	6	6
Industry Representative's Presentation	2	2	2	2	2		2	2	2	-	-
Instructional Technology Presentation Video-Tape	2	2	2	2	2		2	2	2	2	2
Thursday											
Curriculum Development (Small Groups)	4	4	4	4	8		4	4	4	4	8
Industry Representative's Presentation	2	2	2	2	-		2	-	2	2	-
Instructional Technology Presentation, Feedback Systems	2	2	2	2	-		2	2	2	2	-
Friday											
Curriculum Development (Small Groups)	8	8	8	8	8		8	8	8	8	8
SECOND WEEK											
Monday											
Curriculum Analysis and Correction	8	8	8	8	8		8	8	8	8	8
Tuesday											
Curriculum Analysis and Correction	4	4	4	4	4		4	4	4	4	4
Industry Representative's Presentation	2	2	2	2	2		2	2	2	2	2
Instructional Technology Presentation Programmed & Multi-Media Instruction	2	2	2	2	2		2	2	2	2	2

DAYS	AS	ASC	PTM	PSC	GC	AS	ASC	PTM	PSC	GC
SECOND WEEK (continued)										
Wednesday										
Curriculum Analysis and Correction	4	4	4	4	4	6	6	6	6	4
Industry Representative's Presentation	2	2	2	2	2	-	-	-	-	-
Instructional Technology Presentation, Teacher Exams, Grading, and Record-Keeping	2	2	2	2	2	2	2	2	2	2
Thursday										
Curriculum Analysis and Correction	4	4	4	4	4	4	4	4	8	4
Industry Visitation	4	4	4	4	4	4	4	4	-	4
Friday										
Final Developed Sections	8	8	8	8	8	8	8	8	8	8

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*Workshop Abbreviations:

AS - Airframe Structures
ASC - Airframe Systems & Components
PTM - Powerplant Theory & Maintenance
PSC - Powerplant Systems & Components
GC - General Curriculum

APPENDIX C

INDUSTRY REPRESENTATIVES' PRESENTATIONS

FIRST WORKSHOP: Airframe Structures
April 29, 1968 - May 10, 1968

CARL MAY, Aztec Division, Piper Aircraft
"Piper Aircraft Structures"

BUD MILLER, Airflite Corporation
"Cessna Structures and Rigging"

GEORGE SOBODOS, Trans World Airlines
"Bonded/Laminated/Honeycomb Structures"

DEL SPILLMAN, Norman Larson Company
"What's New In Beechcraft Structures?"

R. W. WEBER and EARL CARLTON, Cherry Rivet Division, Townsend Co.
"The Latest in Rivets and Fasteners"

SECOND WORKSHOP: Airframe Systems & Components
May 20, 1968 - May 31, 1968

JAY AKERMAN, General Electric
"General Electric Time Sharing System"

BILL BERLINER, The Flying Tiger Line
"Maintenance Training at The Flying Tiger Line"

JACK BURLEW, Brittain Industries, Inc.
"Autopilot and Navigation Systems"

BERT DRAPER, United Airlines
"Maintenance Training at United Airlines"

BOB FIELDS, Gunnell Aviation, Inc.
"Cessna Single and Multi-Engine Aircraft Systems"

THIRD WORKSHOP: Powerplant Theory & Maintenance
June 17, 1968 - June 28, 1968

JAY AKERMAN, General Electric
"General Electric Time Sharing System"

IVAN GUNTON, Avco-Lycoming
"Latest Developments in Powerplants"

WILLIAM HEACOCK and FRED TIEDEMANN, Pratt-Whitney Aircraft
"Turbine Engine Maintenance"

JERRY PASCARELLA, Trans World Airlines
"Overview of New Developments in Powerplant Maintenance"

DEL SPILLMAN, Norman Larson Company
"Maintenance Requirements for General Aviation Aircraft"

FOURTH WORKSHOP: Powerplant Systems & Components
July 15, 1968 - July 26, 1968

JAY AKERMAN, General Electric
"General Electric Time Sharing System"

RAY FULTON, Santa Monica Propellers
"Propeller Inspection and Maintenance"

CARL JENSON and BOB WILCOCK, Bendix Corporation
"Magnetos and Ignition Systems"

ARLO SPANGENBERG, Airesearch Division, Garrett Corporation
"Characteristics and Maintenance Requirements of Turbosuperchargers"

DICK VOLK, Western Airlines
"Maintenance Requirements of Current Powerplant Systems"

FIFTH WORKSHOP: General Curriculum
August 12, 1968 - August 23, 1968

JAY AKERMAN, General Electric
"Computer Time Sharing System of General Electric"

HOWARD DODGE, United Airlines
"United Airlines Curriculum for the Training of Apprentice Mechanics"

BOB FIELDS, Gunnell Aviation, Inc.
"Wet Wing and Electrical Systems"

R. H. HALLSTED, Trans World Airlines
"Role of the Mechanic in Turbine Powerplant Maintenance"

SIXTH WORKSHOP: Airframe Structures
October 21, 1968 - November 1, 1968

ADOLFO ASTORGA, Ted Smith Aircraft
"Design and Construction of the Aerostar"

JACK REDMOND, Federal Aviation Administration
"FAA Publications, Records, and Forms"

GEORGE SOBODOS, Trans World Airlines
"Techniques for Repairing Honeycomb/Bonded/Structures"

R. W. WEBER and EARL CARLTON, Cherry Rivet Division, Townsend Co.
"Installation and Application of Various Fasteners and Tooling"

SEVENTH WORKSHOP: Airframe Systems & Components
November 11, 1968 - November 22, 1968

JACK BURLEW, Brittain Industries, Inc.
"Installation and Maintenance of Brittain's Autopilot and Navigation/Communication Systems"

RILEY DRAKE and WARREN SWEETNAM, Airesearch Division, Garrett Corporation
"Atmosphere Control Systems"

SEVENTH WORKSHOP (continued):

BILL TONGE and E. M. ZERR, B. F. Goodrich Company
"Techniques and Mechanic Skills in Maintaining B. F. Goodrich Products"

EIGHTH WORKSHOP: Powerplant Theory & Maintenance
January 13, 1969 - January 24, 1969

FORD GAULTNEY, Continental Motors
"Recent Developments in Powerplant Maintenance at Continental Motors"

IVAN GUNTON, Avco-Lycoming
"Recent Developments in Powerplant Maintenance at Avco-Lycoming"

R. H. HALLSTED, Trans World Airlines
"Recent Developments in Powerplant Maintenance at Trans World Airlines"

JIM HURBEIN, Pratt Whitney Aircraft
"Recent Developments in Powerplant Maintenance at Pratt Whitney Aircraft"

NINTH WORKSHOP: Powerplant Systems & Components
February 17, 1969 - February 28, 1969

FORD GAULTNEY, Continental Motors
"Latest Advances in Powerplant Design"

JOEL GODSTON, Airesearch Division, Garrett Corporation
"Turbine Engine Maintenance"

CARL JENSON, Bendix Corporation
"Current Concepts and Techniques of Maintaining Powerplant Systems, Part I"

R. E. WEILLER, Pacific Airmotive Corporation
"Current Concepts and Techniques of Maintaining Powerplant Systems, Part II"

TENTH WORKSHOP: General Curriculum
March 17, 1968 - March 28, 1968

BILL GLENN, Federal Aviation Administration
"FAA Forms, Publications, and Records"

RICHARD LOONEY, Universal Airlines
"Technical Training Requirements for Mechanics of Large Supplemental Carriers"

HAROLD PEARSON, McDonnell-Douglas Corporation
"New Materials and Processes in Aviation Mechanics"

APPENDIX D

PARTICIPATING COMPANIES – PART TWO, PHASE 3

AIRLINE LINE STATIONS

1. Alaska Air Lines
   Seattle, Washington

2. American Airlines
   Boston, Massachusetts
   Cincinnati, Ohio
   Cleveland, Ohio
   Flushing, New York
   Los Angeles, California

3. Braniff International
   Dallas, Texas

4. Continental Airlines
   Denver, Colorado

5. Delta Air Lines
   Dallas, Texas
   Washington, D.C.

6. Flying Tiger Lines
   San Francisco, California

7. Los Angeles Airways
   Los Angeles, California

8. New York Airways
   Flushing, New York

9. Northwest Orient Airlines
   Minneapolis, Minnesota

10. Pan American Airways
    Portland, Oregon
    San Francisco, California

11. Seaboard World Airlines
    New York City, New York

12. Southern Airways
    Atlanta, Georgia

13. Trans World Airlines
    Chicago, Illinois
    Los Angeles, California
    New York City, New York

14. United Air Lines
    Atlanta, Georgia
    Chicago, Illinois
    Denver, Colorado
    Detroit, Michigan
    Los Angeles, California
    Philadelphia, Pennsylvania
    Portland, Oregon
    San Francisco, California
    Seattle, Washington
    Washington, D.C.

15. Western Air Lines
    Denver, Colorado

AIRLINE OVERHAUL

1. American Airlines
   Tulsa, Oklahoma

2. Braniff International
   Dallas, Texas

3. Continental Airlines
   Los Angeles, California

4. Delta Air Lines
   Atlanta, Georgia

5. Frontier Airlines, Inc.
   Denver, Colorado

6. Northeast Airlines
   Boston, Massachusetts

7. Northwest Airlines
   Minneapolis, Minnesota

8. Pan American Airways
   Miami, Florida

9. Trans World Airlines
   Los Angeles, California

10. United Air Lines
    San Francisco, California

11. World Air Center
    Oakland, California

LARGE GENERAL

1. **Aero Copter, Inc.**
   Seattle, Washington
2. **Aircraft Repair & Service Co.**
   Tulsa, Oklahoma
3. **Aircraftsmen, Inc.**
   Oklahoma City, Oklahoma
4. **Airesearch Aviation Service Co.**
   Los Angeles, California
5. **AirFlite and Serv-A-Plane, Inc.**
   Freeland, Michigan
6. **Allied Helicopter Service, Inc.**
   Tulsa, Oklahoma
7. **Atlantic Aviation Corp.**
   Worcester, Massachusetts
8. **Beckett Aviation Corp.**
   West Mifflin, Pennsylvania
9. **Beech Aircraft Corp.**
   Witchita, Kansas
10. **Beechcraft West**
    Van Nuys, California
11. **Buffalo Aeronautical Corp.**
    Buffalo, New York
12. **Capitol Sky Park, Inc.**
    Sacramento, California
13. **Collins Aviation Service**
    Seattle, Washington
14. **Combs-Gates Aviation, Inc.**
    Denver, Colorado
15. **Commander Service Center**
    Bethany, Oklahoma
16. **Denver Beechcraft, Inc.**
    Denver, Colorado
17. **Des Moines Flying Service, Inc.**
    Des Moines, Iowa
18. **Eight Air Dept, Inc.**
    Sebring, Florida
19. **Erie Airways, Inc.**
    Erie, Pennsylvania
20. **Executive Beechcraft, Inc.**
    Kansas City, Louisiana
21. **Executive Jet Sales, Inc.**
    Columbus, Ohio
22. **Flightcraft, Inc.**
    Portland, Oregon
23. **Gee Bee Aero**
    San Jose, California
24. **Gen Aero, Inc.**
    San Antonio, Texas
25. **Gunnell Aviation, Inc.**
    Santa Monica, California
26. **Helicopter Services Co.**
    Yakima, Washington
27. **Houston Beechcraft**
    Houston, Texas
28. **Howard Associated - Pase**
    San Antonio, Texas
29. **Kerr Aviation Service, Inc.**
    Bethany, Oklahoma
30. **Lear Jet Industries**
    Witchita, Kansas
31. **Lockheed Aircraft Service**
    Jamaica, New York
32. **Love Field Air Center, Inc.**
    Dallas, Texas
33. **M. H. Spinks Industries**
    Ft. Worth, Texas
34. **Modern Aero Service, Inc.**
    Dallas, Texas
35. **Newark Air Service, Inc.**
    Newark, New Jersey
36. **Northern Air**
    Grand Rapids, Michigan
37. **Oak Grove Air Port**
    Fort Worth, Texas
38. **Pacific Airmotive Corp., Inc.**
    Burbank, California
39. **Patterson Aircraft Co.**
    Sacramento, California
40. **Ragsdale Aviation, Inc.**
    Austin, Texas
41. **Reading Aviation, Inc.**
    Allentown, Pennsylvania
42. **Renton Aviation, Inc.**
    Renton, Washington

LARGE GENERAL (continued)

43. Revere Aviation, Inc.
    Beverly, Massachusetts

44. Showalter Flying Service
    Orlando, Florida

45. The Boeing Co.
    Renton, Washington
    Seattle, Washington

46. Yingling Aircraft, Inc.
    Wichita, Kansas

SMALL GENERAL

1. Acme Aircraft Co.
   Torrance, California

2. Aero Jet General Corporation
   Ontario, California

3. Aircraft Service, Inc.
   Cleveland, Ohio

4. Al Sos Aviation
   Chico, California

5. Boise Aviation and Spark's Flying Service
   Boise, Idaho

6. Butler Aviation
   San Francisco, California

7. Carleton-Whitney Aero Service
   Mansfield, Massachusetts

8. Cincinnati Aircraft, Inc.
   Cincinnati, Ohio

9. Clark's Flying Service
   Nampa, Idaho

10. Davis Pier Service, Inc.
    Kelso, Washington

11. Eastman Kodak Co.
    Rochester, New York

12. El Cajon Flying Service
    Santee, California

13. Flyways, Inc.
    Albany, Oregon

14. FMC Corporation.
    San Jose, California

15. Lockheed Aircraft Service Co.
    San Jose, California

16. Mahon's Boot Hill Flying Service
    Dodge City, Kansas

17. Pacific Airmotive, Inc.
    Seattle, Washington

18. Pendleton Airmotive, Inc.
    Pendleton, Oregon

19. Price Piper, Inc.
    Spokane, Washington

20. Pueblo Aircraft Service
    Pueblo, Colorado

21. Red Carpet Flying Service
    Walla Walla, Washington

22. Richland Aviation, Inc.
    Mansfield, Ohio

23. Richland Flying Service, Inc.
    Richland, Washington

24. Salem Aviation, Inc.
    Salem, Oregon

25. Schweizer Aircraft Corp.
    Elmira, New York

26. Thunderbird Aero Enterprises, Inc.
    Everett, Washington

27. TideAir, Inc.
    Gig Harbor, Washington